SOME, FOR ALL, FOREVER

Emerging development of Integrated Water Resources Management in non-Nile Sudan

July 2016

Preface and acknowledgements

This report reflects the consultations and awareness raising undertaken on Integrated Water Resources Management (IWRM) in Sudan between 2007 and 2014. The work grew out of efforts in Darfur to coordinate water resources management in the context of the rapid urbanisation and upheaval associated with the crisis. In order to develop a new vision for water management in Darfur, UNEP coordinated an exchange programme with South African water managers. The purpose was to share experiences on how more equitable access to water can be achieved in the aftermath of social upheaval and change[1]. At the request of the Minister of Irrigation and Water Resources, the initiative shifted to a national perspective for non-Nile water management.[2] The Darfur International Water Conference in 2011 was a step forward in raising the profile of IWRM as a broader framework for water management. This led to a consultation on IWRM at the level of federal government in 2012-14. To support this dialogue, a review of approaches to catchment management was published in 2014, with collaboration from UNESCO-IHE.[3] These various dialogues went a long way in contextualising the learning from the original debates on IWRM principles and the application in South Africa. The present report reflects these dialogues and the vision articulated in the statements made by the Sudanese participants on the South African exchange programme (see Annex 1). The recommendations made in the report were endorsed in a meeting with senior representation from the Ministry of Irrigation and Water Resources, the Hydraulic Research Station, the Groundwater and Wadis Unit, the Drinking Water and Sanitation Unit, and the Agricultural Research Station, with additional participants from UN agencies working on water on 23 June 2014.

The work described here has been taken forward with a major effort on catchment management in Wadi El Ku in Darfur. The project has EU funding and is being implemented by UNEP, Practical Action, SOS Sahel and DDRA in collaboration with government and community partners. In other developments, UNDP are working in partnership with the Ministry of Electricity, Water Resources and Irrigation (MEWRI), and with the Ministry of Environment, Natural Resources and Physical Development (MENRPD) on catchment management in Kordofan with Global Environment Facility GEF funding. The Dams Implementation Unit has scaled up its work on non-Nile water resources management with major initiatives on rainwater harvesting. A group of national and international NGOs are working with DFID funding on related work in Darfur and Eastern Sudan. SOS Sahel is working with Excellent Development on implementing sand dams in Kordofan. This report is aimed at supporting these ongoing efforts by providing a record of work on practice and policy that has previously been undertaken.

In the production of the report, particular thanks are extended to H.E. Dr Ibrahim Dukheri, Director of the Agricultural Research Station at the time of the consultations, now Minister of Agriculture and Forests; Prof Yasir Abbas Mohamed, Director of the Hydraulic Research Station and chair of the technical committee for the national vision on IWRM; Dr Badreldin Taha Mohamed, Director General of the Groundwater and Wadis Unit (GWWU) of the Ministry of Water Resources and Electricity (MWRE); Mohi El Din El Kabir, national coordinator for IWRM in the GWWU ; and Hisham Yousif, of the Drinking Water and Sanitation Unit (DWSU) of MWRE. Engineer Hassan Kaskous made important contributions to the development of this work, initially through interaction in his role as Minister of Water Resources and Environment in South Darfur and latterly as a senior technical advisor for UNOPS. His contribution through participation in the field missions reflected in the case studies in this report significantly enriched the reflections on the development of IWRM in Sudan. Within the UN, feedback on proposals in this report from Ram Koirala, Hani El Sadani, El Mardi Ibrahim, Aisha Oschick, Rosanne Marchesich, Sabine Schenk, Min Htut Yin, Hanan Mutwakil and others has been invaluable. Of particular significance is the feedback on earlier drafts from Dr Tariq El Gamry of the Sudan Water Partnership. Ahmed Manies of UNEP has provided important perspectives on the work in addition to his inspirational advocacy for the uptake in Darfur of the ideas described here. The report has been authored by Brendan Bromwich, Dr Hamid Omer Ali and Tayalla El Medani, with contributions from Eiman Karar.

UNEP acknowledges with gratitude both the financial support from and the technical dialogue with DFID, the European Union and the Government of Italy, as well as the collaboration with the Government of the Republic of South Africa.

[1] See this link for details of the exchange programme: http://unep.org/disastersandconflicts/portals/155/countries/Sudan/pdf/SouthSouthCooperationCaseStudy.pdf

[2] See Annex 2 for the details of this collaboration which also included MEFPD, HCENR, UNDP and UNOPS.

[3] http://unep.org/disastersandconflicts/portals/155/countries/Sudan/pdf/SudanWRM.pdf

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Acronyms

AMCOW	African Ministers' Council on Water
BOCMA	Breede Overburg Catchment Management Agency
CBNRM	Community Based Natural Resource Management
CLTS	Community Led Total Sanitation
CPA	Comprehensive Peace Agreement
DDRA	Darfur Development and Reconstruction Agency
DDPD	Doha Document for Peace in Darfur
DDSD	Dam Development Survey in Darfur
DFID	Department for International Development (United Kingdom)
DG	Director General
DRA	Darfur Regional Authority
DWSU	Drinking Water and Sanitation Unit
ENTRO	Eastern Nile Technical Regional Office
ER	Early Recovery
FA	Football Association
FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
GEF	Global Environment Facility
GWP	Global Water Partnership
GWWD	Groundwater and Wadis Department/Directorate (now GWWU)
GWWU	Groundwater and Wadis Unit
HAC	Humanitarian Aid Commission
HCENR	Higher Council for Environment and Natural Resources
IDP	Internally Displaced Person
IFAD	International Fund for Agricultural Development
INGO	International Non-Governmental Organisation
IWRM	Integrated Water Resources Management
JICA	Japan International Cooperation Agency
MEFPD	Ministry of the Environment, Forests and Physical Development (now MENPRD)
MENRPD	Ministry of Environment, Natural Resources and Physical Development (formerly MEFPD)
MIWR	Ministry of Irrigation and Water Resources (now MWRE)
MWRE	Ministry of Water Resources and Electricity (formerly MIWR)
NAP	National Adaptation Plan
NAPA	National Adaptation Programme of Action
NCP	National Congress Party
ND	North Darfur
NGO	Non-Governmental Organisation
NNGO	National Non-Governmental Organisation
NRM	Natural Resource Management
PWC	Public Water Corporation
SECS	Sudanese Environmental Conservation Society
SIEP	Sudan Integrated Environment Programme
SMOH	State Ministry of Health
SMUP	State Ministry of Urban Planning
SWAP	Sudan Water Partnership
SWC	State Water Corporation
TDRA	Transitional Darfur Regional Authority
UK	United Kingdom
UN	United Nations
UNAMID	African Union-United Nations Hybrid Operation in Darfur
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO-IHE	United Nations Educational, Scientific and Cultural Organisation – Institute for Water Education
UN-Habitat	United Nations Human Settlements Programme
UNICEF	United Nations Children's Emergency Fund
UNOPS	United Nations Office for Project Services
WASH	Water, Sanitation and Hygiene
WES	Water and Environmental Sanitation Project
WFP	World Food Programme
WUA	Water User Association

1 Introduction

Sudan is facing multiple processes of change: climate, population growth, urbanisation, upheaval as a result of conflict and changes in the economy. Therefore, the balance of the economy is changing, and so are the livelihoods practised by communities across Sudan. Businesses and communities are drawing on natural resources in different ways. This challenge of adapting to a changing context and creating new initiatives for development and economic growth is a global challenge, in which each country faces a particular set of opportunities, constraints and goals.

As agriculture increases in significance in Sudan's national economy, improving management of water has potential to limit economic shocks caused by droughts and floods. In some cases challenges arise where urban and agricultural water demands compete, as in Kassala, Nyala and El Fasher. Sudan has a significantly higher proportion of arid land than before the secession of South Sudan.[4] These processes of change all have water resource management implications that require attention.

Darfur, South Kordofan and Blue Nile state face conflicts relating to natural resources in addition to conflicts relating to political tensions. The Doha Document for Peace in Darfur (DDPD) calls for the development of "a new framework" for the interaction between herders and farmers. The DDPD mandates new governance arrangements such as the Darfur Regional Authority (DRA) as a means of enabling the interaction of different resource users so an escape from chronic cycles of conflict can be found.

At first, it may appear unusual to approach issues of development and of conflict mitigation together in the same report. The rationale for this is strong, however, for two reasons. Firstly, by developing water management for inclusive economic growth in peaceful areas, a direction of travel for areas emerging from conflict is also developed. For example, if management of water in Khor Abu Habil, in North Kordofan and White Nile State, is strengthened, then useful approaches may be identified to assist in an area such as Wadi Azoum in Central Darfur. And secondly, to promote a national approach to water, there need to be principles that run throughout the Sudanese water sector: for all that there will be different development goals by state, national resources still need to be governed for all.

The report highlights examples from a number of areas of Sudan of good water management implemented by different actors, including both national and international organisations. The report is written to support the work undertaken by the Ministry of Water Resources and Electricity (MWRE), the Ministry of Environment Forests and Physical Development (MEFPD) and UNEP on IWRM and to reflect the vision and recommendations of Sudanese participants in the South African IWRM exchange programme, described below (see Annex 1 for the vision statements). This approach acknowledges the importance of an inclusive collaboration on IWRM, in which numerous organisations are active in Sudan. DFID/UKAID funded a Darfur IWRM project in 2007–2009, and the Sudan Integrated Environment Project (SIEP) in 2009-2014.[5] This report is published in early 2016 in order to inform a new round of programming on natural resources in Sudan, with a focus on climate adaptation and resilience. The "ADAPT" project is set to run from 2015-2019, with funding from the Government of the UK.

The report builds on the core series of publications in the SIEP, which address environmental governance with a peacebuilding objective:

- 'Environmental Governance in Sudan: An expert review', UNEP (2012)[6]

[4] See FAO's Sudan land cover mapping (2012) http://www.glcn.org/activities/sud_lc_en.jsp .

[5] See www.unep.org/sudan.

[6] http://postconflict.unep.ch/publications/UNEP_Sudan_env_gov_review.pdf

Figure 1.1 The interaction of vegetation, soil and water can be clearly seen in these sub-catchments in West Darfur. While not always so visually striking, this alignment with natural processes is a key principle in IWRM (Photo: M Kovac)

- 'Governance for Peace over Natural Resources: A review of transitions in environmental governance across Africa as a resource for peacebuilding and environmental management in Sudan', UNEP (2013)[7]
- 'Relationships and Resources: Environmental governance for peacebuilding and resilient livelihoods in Sudan', UNEP (2014a)[8]

Within the IWRM theme of SIEP, the report builds on the following work:

- 'Water Resource Management in Humanitarian Programming in Darfur: The case for drought preparedness', UNEP (2008)[9]
- 'Towards IWRM: International experience in development of river basin organisations', UNEP (2014b)[10]

This report discusses initiatives and challenges on IWRM in Sudan, and also reflects on experiences gained by Sudanese water managers through the South African collaboration. The technical role of the Water Research Commission in South Africa has been an important thread running through this programme. This "South – South collaboration" has been a significant step for the IWRM agenda in Sudan.[11] Exchanges with South Africa have been milestones in the translation of IWRM from an abstract concept to something that is perceived to add value in the day to day challenges of the water sector. Reflecting the impact of this collaboration, this report continues the spirit of learning together by analysing South African case studies alongside Sudanese examples. Post-apartheid, post-conflict reforms in South Africa endeavoured to create a more equitable water sector based on principles of participation and sustainability. Twenty years on, the impact of these reforms can be assessed, with clear relevance to the search for conflict mitigation and inclusive economic growth in Sudan.

7 http://unep.org/disastersandconflicts/Portals/155/countries/sudan/pdf/Governance%20for%20Peace_Sudan_Web.pdf

8 http://postconflict.unep.ch/publications/UNEP_Sudan_RnR.pdf

9 http://postconflict.unep.ch/publications/darfur_drought.pdf

10 http://unep.org/disastersandconflicts/portals/155/countries/Sudan/pdf/SudanWRM.pdf

11 http://unep.org/disastersandconflicts/portals/155/countries/Sudan/pdf/SouthSouthCooperationCaseStudy.pdf

The aim of the report is therefore to stimulate dialogue on the further development of Sudan's IWRM agenda by discussing aspects of what has been achieved so far. The report does not give an exhaustive list of work on IWRM to date, but makes a contribution to the wider development of this approach to water resource management in the specific environmental and social context of the country.

The vision statements that were produced by delegates under the collaboration with South Africa are shown in Annex 1. The joint concept paper that emerged on the basis of those consultations is in Annex 2. As part of the consultation for this report, a contribution on the emerging IWRM agenda in Sudan made by the Drinking Water and Sanitation Unit (DWSU) is shown in Annex 3. As described in Annex 2, this initiative on IWRM had three components:

- A higher level policy and awareness raising element supporting the development of the national vision for IWRM;
- The development and implementation of water resources projects, particularly catchment based (such as Wadi El Ku);
- A capacity building role, providing support to Groundwater and Wadis Unit in particular.

The intention in writing this report at this time is to support initiatives across these three priorities as a new phase of programming develops.

2 Integrated Water Resources Management in the context of Sudan

Key points:

- *IWRM is an inclusive and holistic approach to management of water. Water is managed from the perspective of the entire resource, acknowledging all the different uses and users, rather than from the perspective of one set of water demands at a time. The basis of this approach is found in the Dublin Principles.*
- *Water is needed as a platform for economic growth now and in the future in Sudan. This requires the resource to be managed sustainably. Genuine sustainability also implies social equity, and therefore a sustainability framework contributes to the prospects of peace as well as economic growth.*
- *This report draws its analytical framework from the need to manage water resources for economic growth, basic needs and as the lifeblood of the environment. In the sustainability discourse this is known as integrating (or balancing) the three E's: Economy, Social Equity and Ecology.*

2.1 Integrated Water Resources Management

There is a logic to the conventional approach of managing water demand and resource balances on a case-by-case basis. The logic breaks down, however, where competing demands make resource allocation more complex, and a holistic approach is needed. The conventional approach has also been challenged by growing awareness of the value of water to the natural environment and the benefits to society of healthy ecosystems. Historically, whether for urban use, agriculture or industry, the key element in conventional water management has been to work out how much water will be needed over the long term and find the most cost-effective way of securing a reliable and lasting source. The built-in assumption, however, is that the water will not be needed by others, or necessary for the healthy functioning of the environment. This is a demand-centred approach to water management.

A question arises, then, about how water can be managed in a way that does not lead to competing demand-centred approaches, but looks at water holistically and allocates it in the way that is most beneficial to society, given multiple competing priorities. This question is one faced by countries around the world:

- South Africa faces a dilemma of allocating its water to the mining industry or for agriculture, given that both sectors are essential to the economy and that water is also needed by the large sector of the population struggling with poverty. Resource allocation needs to reduce social inequality as well as enabling the overall economy to grow.
- Australia over-allocated its water resources, giving entitlements to farmers that cannot be sustained. As a result, the country's largest river, the Murray-Darling, had sections with very little water, creating significant problems of low water quality. Since 2007 the government has started a major buy-back of water rights from farmers, so that there is more incentive for farmers to use water more efficiently.
- In response to a growing food demand from a rising population, Saudi Arabia sought to use its oil revenues to develop a national agricultural programme through the 1980s and '90s. By the mid-90s, however, it became clear that the overall resources of groundwater were being depleted, and ultimately a ban on the

use of groundwater for agriculture came into force in 2013. Water continues to be allocated for higher-value industrial uses and domestic uses, but greater emphasis on importing food from more water rich countries will be needed to offset the loss of food production.[12]

Integrated Water Resources Management is an approach to water that reflects the need to manage the resource holistically, and can be contrasted with conventional demand-based water management, as shown in the Table below.

Demand-based water management	Integrated Water Resources Management
Driven by one type of water demand	Management of the entire resource
One or few institutions involved	Many institutions involved
One sector objectives addressed	Multiple sector objectives addressed
Decisions made in one sector	Collective decision making with multiple sectors and representatives of water users
Managed on political boundaries	Managed on hydrological boundaries (the river catchment or groundwater basin)

The switch from managing single to multiple water demands is enabled by bringing representation from different water users into the decision making processes: these may be farmers, pastoralists, urban resident associations, owners of factories and similar representatives. Given the important role that women have as water users – in particular in the domestic context and in subsistence agriculture - IWRM has a particular emphasis that their voice should be central to the management of water. Another important consideration is that the water used within the environment is taken into account in decision making. Environmental NGOs or academics are often consulted as part of this effort to find a "voice" that speaks for the priorities of the ecosystem.

In addition to ensuring that voices for all competing water demands are heard, another important step to managing the resource as a whole is that the geographical area managed is defined by hydrological boundaries alongside the political boundaries. Political boundaries may cut across water resources, making it impossible to manage all of the resource. By managing according to hydrological boundaries, one is working with nature rather than across it. In managing a catchment, dialogue between upstream and downstream water users can be organised. The alignment with environmental processes means, for example, that the interaction between soil and water in the catchment can be reflected. Therefore, if silting of downstream reservoirs is a problem, part of the solution will involve improved erosion control upstream in the same catchment.

Water allocations may be subject to political constraints that cut across the ideal of managing the catchment, so a balanced approach is needed to tackle issues in a nuanced way, mindful of both the political and the hydrological factors.[13] In some cases, the catchment may be too large for a single approach to management, and multiple approaches including management of sub-catchments may be needed. In other cases, catchments are hard to define and an aquifer may be more relevant as the unit by which

[12] Globally, food production is by far the largest use of water by man. Some 70% of water use is for agriculture, 20% for industry and power generation and 10% for domestic needs (UNEP 2011). However since domestic and water allocations can be used and reused the figure for consumption is even more heavily weighted to agriculture. Some 90% of water consumption is in agriculture.

[13] Allan (2001) refers to the need to address political issues in the wider "problemshed" in addition to addressing the hydrology in the watershed.

water is managed. Flexibility is important, so that the most appropriate approach for the context is used. IWRM should not be seen as a prescriptive approach to water – implicit in the emphasis on participation is a flexibility and adaptability of the principles to a given context. Some writers prefer the term "adaptive" water resource management to IWRM, emphasising the fact that the principles need to be contextualised.[14] The vision statements given in Annex 1 draw out particular emphases of the IWRM approach with relevance for Sudan, and so give an example of an adaptive approach.

The institution with responsibility to advocate and coordinate uptake of IWRM is the Global Water Partnership (GWP). The GWP was established in 1996 to reflect the importance of water in the broader sustainable development agenda. Describing itself as a "global action group", it is custodian of the principles of IWRM as shown in the Box below.

These principles have been reflected in the discussion above. The first principle establishes the connection between water for life, development and environment, making the case that it should be managed holistically. This sets the basis of the management of water according to hydrological boundaries, which has resonance with other ecosystem-based approaches such as Integrated Coastal Zone Management, Integrated Mountain Ecosystems Management, Drylands Management and Wetlands Management. Ecosystems-based approaches have advantages in integrating responses to multiple societal challenges such as poverty reduction, adaptation to the impacts of climate change and disaster risk reduction. By taking an ecosystems-based approach, all of these objectives can be addressed together (Munang et al. 2013). Ecosystems-based approaches draw on the indigenous knowledge of farmers and herders, given their experience in managing natural resources in the face of these concurrent challenges. This is particularly significant in the context of the variability of availability of water in dryland ecosystems, where traditional knowledge has important insights on maintaining balanced use of water, rangeland and other resources.

Principles of IWRM

1. Water is finite and vulnerable resource

Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.

2. Participatory approach

Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.

3. Role of women

Women play a central part in the provision, management and safeguarding of water.

4. Social and economic value of water

Water is a public good and has a social and economic value in all its competing uses.

5. Integrating three E's

Integrated water resources management is based on the equitable and efficient management and sustainable use of water.

Source: http://www.gwp.org/en/The-Challenge/What-is-IWRM-Principles/

[14] For example, see Lankford and Hepworth (2006) or Lankford et al. (2007).

2.2 The context for IWRM in non-Nile Sudan

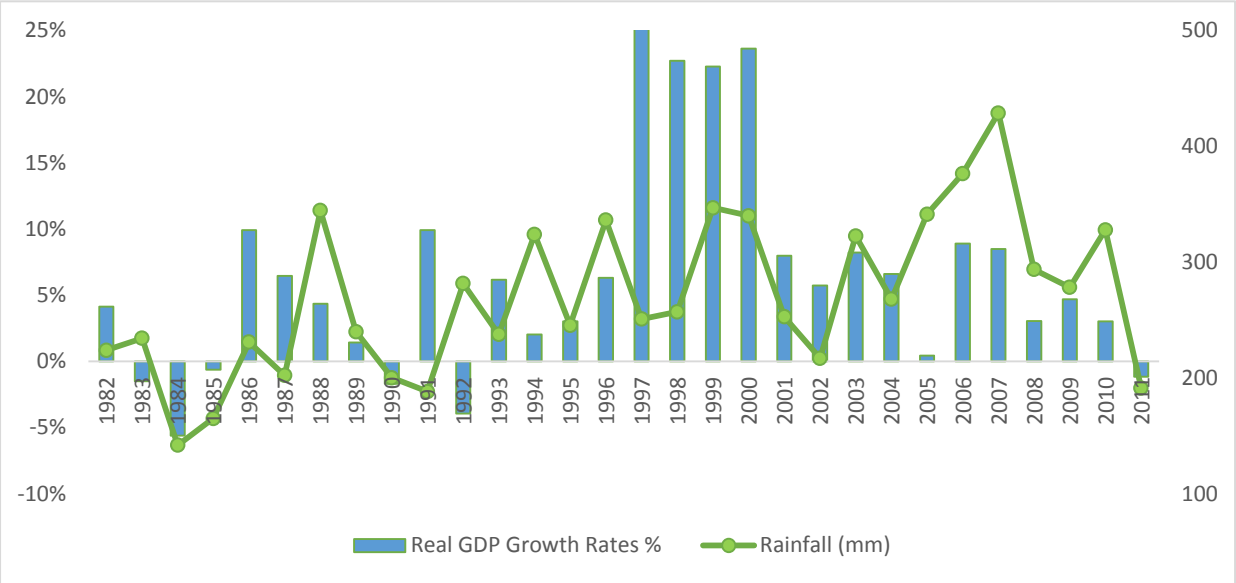

Figure 2.1 Sudan Real GDP Growth Rates 1980-2012 (1997 growth of 62% not shown graphically in full) and composite rainfall data (El Fasher, Nyala, El Obeid, Khartoum, Wad Medani) Sources: GDP - IMF World Economic Outlook April 2014[1], rainfall data from multiple sources

The importance of water for supporting life, for the economy and for cultural and social activities resonates well in the context of Sudan. There is a wealth of cultural affinity with water in Sudan, not least with its important role in Islam and in the warm hospitality to visitors that features so highly in Sudanese culture. Yet water is also vital to the economy through its impact on agriculture.

The graph above shows GDP growth in Sudan from 1980 to 2012. A period of sustained growth is evident from the mid-1990s to 2010, as the oil fields came on stream and began to transform the economy. (The growth of 62% in 1997 was exceptional as a result of the first oil revenues coming in. 2005 saw a plateau, when new oil output was delayed.) During the period prior to 1997, however, growth was much more irregular, while Sudan was largely an agricultural economy. Two important variables in agricultural GDP growth are commodity prices and the size of the harvest. The amount and the timing of rainfall in a given year has an important impact on the size of the harvest. With the loss of much of the country's oil production following the secession of South

Sudan, the importance of agriculture in the economy is increasing. This makes a compelling economic case for investing in water resources management as a means of reducing the risk of years of low economic growth in Sudan, in addition to the direct impact on food security.

This case is made stronger by a consideration of some of the dynamics involved. The figure below shows the length of the rainy season in El Fasher for the years 1943 to 1999.[15] The horizontal line on the graph indicates the length of the growing season for millet of 75 days. What can be seen here is that short rains are a major challenge for farmers. This makes the case for investment in rainwater harvesting techniques that can extend the period for which moisture is available in the soil for plant growth.[16] Grazing is also important as mobile livestock can cope with variable water resources as discussed in Section 4.

[15] This analysis was undertaken as part of the early work on the Wadi El Ku catchment management project to identify what interventions should be made in the catchment to promote livelihoods in the area. The selection of years is a function of the availability of data.

[16] For more information on buffering catchment with a "3 R" framework (Recharge, Retention and Reuse), see http://www.bebuffered.com/

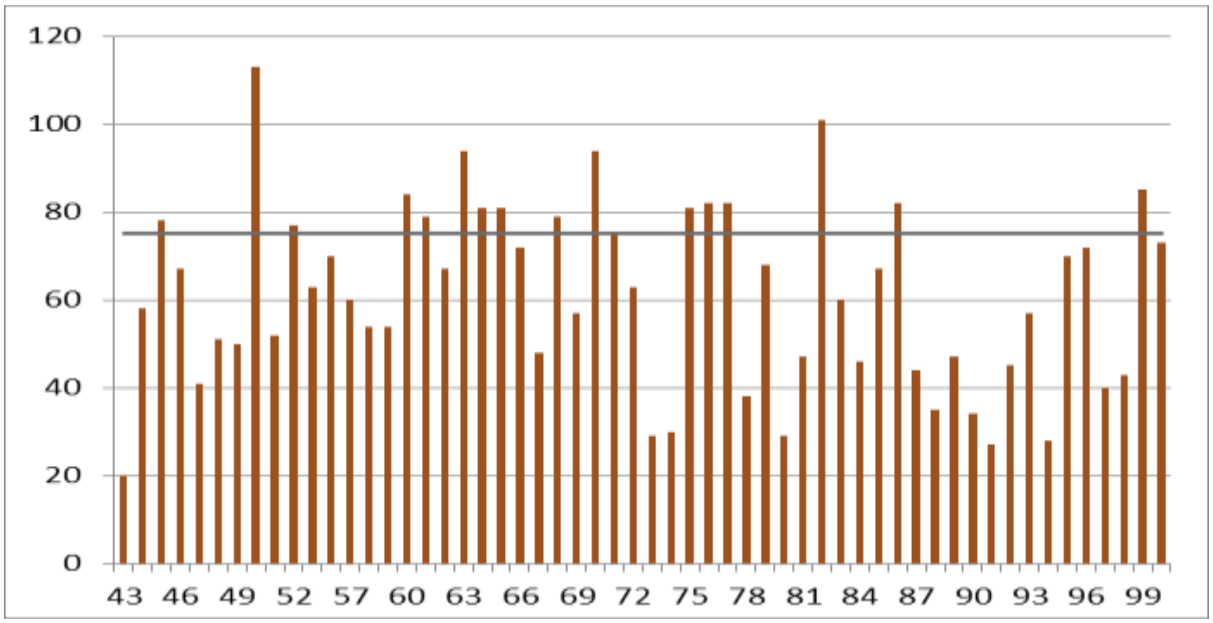

Figure 2.2 Length of the cropping season in the El Fasher area, 1943–2000. The horizontal line indicates the minimal length required for a good crop of millet (75 days). Source: UNEP (2014c)

The new emphasis on agriculture is not just a function of the changing economy within Sudan, but also needs to be seen with respect to water use across the Middle East. Water shortages in Gulf Arab states are driving agricultural investment in many parts of Africa, including Sudan. Sudan may be understood as exporting "virtual water", with respect to the water used to create its agricultural products.[17]

Water in Sudan is critical to the informal economy, as well as to the formal economy. The livestock sector is a vital element of Sudan's economy, but much of this is outside the formal economy and managed with traditional systems. These traditional governance arrangements, while well informed on natural resource management, have not succeeded in preventing conflict in the face of the current drivers of change. Conflict has not simply been between different traditional livelihoods, such as farmers and pastoralists, but also at the interface between modern agricultural schemes and traditional livelihood groups. In this context, the need to update governance mechanisms for natural resource access becomes clear.

2.3 Governance of natural resources

This report also relates to the specific programme informing dialogue for rebuilding governance in conflict areas such as Darfur and supporting governance in conflict-prone areas elsewhere in Sudan. The report "Governance for peace over natural resources" (UNEP 2013) reviewed reforms in environmental governance in various parts of Africa as a resource for dialogues on governance within Sudan. Two important themes from that report are worth noting for the current discussion on governance relating to water.

[17] See Allan (2011) for an overview of virtual water; and Zeitoun, Allan and Mohieldeen (2009) for a review of virtual water in the Nile Valley.

Figure 2.3 This dam on the edge of the city of El Gedaref is relevant for the storage of both surface water and groundwater. Wells can be seen downstream of the dam, which draw on groundwater recharged because of the dam. This "conjunctive use" of groundwater and surface water is an important technical dimension of IWRM

Firstly, across the world, the interface between customary governance and formal government is dynamic. In Canada, South America and elsewhere customary representation of "indigenous" populations has been increasing, and this has been reflected in constitutional amendments. In Africa, customary systems have particular relevance to dispute resolution and land management. This makes them relevant to rural water management, given the importance of water in livelihoods such as pastoralism, agriculture and forestry upon which a large proportion of the rural population of Sudan depends. Surveys undertaken by Afrobarometer in 19 countries in Africa indicate aspirations for a greater role for traditional leadership on these issues (Logan 2012).

The second discussion to highlight as relevant to this report relates to the different roles government can take as service provider or as convener of co-management arrangements. Some forms of governance can be conceptualised more as vertical relationships: citizens pay taxes and the government, or an agent of the government, provides a service, as in refuse collection or water supply in urban areas. Alternatively, other forms of environmental governance may be conceptualised as horizontal relationships. Examples include community forestry and some traditional agreements between pastoralist and farming communities.

A useful analogy for the role of government in these arrangements is with the role of the Football Association (FA). The FA does not provide balls, pitches or other items used in the game but is custodian of the rule book enabling teams to come together on the basis of the rules in the book.

At the heart of the two models is an agreement, or social contract. The vertical model exchanges taxes for services, whereas the horizontal model is an agreement between different resource users (e.g. pastoralists and farmers) over shared resources. There is some overlap, however: for instance, urban residents store their solid waste in a way that is considerate to their neighbours as it awaits collection by the municipal authorities.

With water, the degree of technology used will have an impact on the nature of the governance arrangements. Generally, it is reasonable to consider higher technology and cost as being significant in putting arrangements beyond the capacity of community management; however, there are interesting examples in Sudan, such as the

Hawata project, that demonstrate water users providing useful oversight over relatively complex systems. Clearly, external support is needed for technical issues, but providing this capacity is not the same as taking overall responsibility for the ongoing management of the scheme.[18]

One of the largest challenges facing the Sudanese water sector is the maintenance of heavily silted hafirs. Here the comparison of vertical or horizontal governance arrangements is particularly relevant. In a purely vertical arrangement, the role of government is to desilt all the hafirs, ideally with some form of cost recovery from the communities who use them. This is a considerable challenge given the vast size of Sudan, the number of hafirs and the logistical and managerial implications of the task. Alternatively, an arrangement can be made whereby local committees collect fees from the water users and the money stays in the community in order to fund the desilting on a year-by-year basis. This arrangement needs oversight, and contribution from government if heavy machinery is required, but enabling local management and accountability has potential to bring new urgency to the maintenance of hafirs.

2.4 Analytical framework

The analytical framework for the report is based on the balancing of the three Es for sustainability. These are addressed with the following three questions:

- *Question 1 - Environmental sustainability/ water resource balance – is the water use within the limit of the available resources?*
- *Question 2 - Economic sustainability/ financial resource balance - is the cost of production and distribution recovered by the revenues collected and/or other reliable sources?*
- *Question 3 – Effective local management – are management arrangements sufficiently effective and locally accountable to ensure decisions made meet the requirements for environmental and economic sustainability and respond to the needs of the community served?*

The three questions above are designed to assess the way in which the three Es are balanced for a sustainable water resource management programme.

The first question asks if the water use exceeds the sustainable limit of the resource. If it is excessive, then in the case of groundwater the aquifer will be drawn down, and in the case of surface water, insufficient water will be available to downstream users. Drawing down the aquifer may also lead to unavailability of water to other users, particularly those whose wells are less deep. For both surface water and groundwater, an overused and poorly managed resource may show a decline in quality in addition to a decline in quantity of water. The water resource balance is the focus of the review of environmental sustainability, but the impact of water supplies on other resources is also relevant.

The second question asks if there is a balance, with enough revenue being collected for the system to be properly maintained, or if there are other reliable sources for the ongoing funds required. The balance of funding from users and other sources is an important political consideration in water governance. If there is inadequate funding, then services are interrupted and it may be that people are less willing to pay for the service. A negative spiral of poor service, user dissatisfaction, lower revenue collection and insufficient funding for maintenance can occur. Alternatively, if the service is well maintained then there is greater acceptance of the need to pay, and a well-managed cycle of revenue collection and expenditure on maintenance can be achieved. Related to issue of payment for water are the issues of the right to water and of traditional social obligations to provide water. Water needs to be understood in political, cultural terms in addition to financial and technical

[18] It is important that technical elements are not neglected in aid programmes. Numerous collapses of small and medium dams have occurred in Darfur in recent years (UNOPS 2013), and groundwater monitoring and analysis in Sudan is still patchy. Technical capacity in water resource engineering in the aid sector requires strengthening.

terms. This question acknowledges the complexity of the context but focuses on financial considerations as to whether funds are sufficient for ongoing operation and maintenance.

The third question looks at the management arrangements behind the first two questions and also brings in additional issues of social equity. Where decisions are made locally with the participation and/or oversight of water users, then the decisions about revenue collection and levels of water use can be made in a way that is more acceptable to water users. Limits on availability and increases in price are easier for users to accept when they genuinely understand what has led to these and consider the decisions to have been made on a suitable basis.

In formal terms, the third question relates to "subsidiarity" – that decisions are made at the lowest practical level. This requires a balance between being low enough and close enough to involve and be transparent to local water users, and having sufficient input from technical experts that the capacity for technical decisions is present. By focussing on the voice of water users, this question is intended to pick up other concerns, such as: the voice of women in the process; provision of an adequate supply to those unable to pay; and other concerns, such as environmental impacts. This framework is not exhaustive, but is intended to provide a focus on some fundamental elements of sustainable water resource management.

3 Catchment management

Key points:

- *Managing water in the environment is best done within geographical boundaries defined by the water itself – catchments or aquifers. The Groundwater and Wadis Unit of MWRE has set up a new management unit and a national database that allows for this.*
- *Ar Keweit in the Red Sea Hills is the location of an important project demonstrating community management of a wadi catchment. Local communities contribute labour and money to manage the wadis to combat soil erosion and manage shallow aquifers to enhance agricultural production.*
- *In South Africa, Hex Valley (visited by Darfuri water managers and government representatives in 2010) gives an important example of community collaboration enabling water to be managed for the benefit of commercial farming activities. The work is done inclusively so that the established white-owned grape farms and the emerging black-owned collective farms both benefit. This provides a model relevant for Sudan in that the economy is supported and potential conflict between groups that could compete over access to water is reduced.*
- *In Sudan, priorities for catchment-based approaches include the Gash Delta in Kassala State, Wadi El Ku in North, South and East Darfur and Khor Abu Habil in North and South Kordofan, amongst others.*

The most important catchment in Sudan is, of course, the Nile, a catchment that lies within a total of 11 countries. The same principle of managing water within the Nile catchment for the benefit of all the riparian countries applies to managing catchments within countries for all water users. Similarly, groundwater can be managed for all users at the aquifer or basin scale. Where groundwater and surface water systems are connected, they need to be managed together – this is relevant to Sudan, which has several large cities adjacent to agricultural areas, including El Fasher, Nyala, El Obeid, Kassala and Kadugli.

Work in the catchment reflects the natural processes of the soil and water. Upstream priorities include soil and water retention, which enable productive livelihoods in the area and also downstream. Water is "buffered" in this way, which means it is available for a longer period of time, smoothing out extremes of floods and scarcity in the dry season.[19] Control of sediment is also important – retaining productive soils upstream and reducing excessive sedimentation downstream.

In Sudan, small-scale catchment projects have been undertaken in Al Khewei and in the Nuba mountains, both to good effect. There are a number of inland deltas in Sudan which constitute particular priorities for catchment management. Where river flows are variable from one year to the next, so is the area of land that can be irrigated. Sharing the benefits from the water is therefore a significant challenge.

In the Gash Delta in Eastern Sudan, an arrangement was developed in which six regions within the delta were each managed in a way that gave farmers access to both upstream and downstream fields, thereby spreading the risk and giving each farmer an interest in equitable upstream and downstream water allocation. Whilst the scheme made some headway due to this inbuilt equitable design, the work was ultimately discontinued, as the interface between traditional, formal and project governance structures did not enable full implementation of the approach – and the approach is only equitable if implemented in full.

[19] See http://www.bebuffered.com/

Case Study 1: Ar Keweit

At different times, Ar Keweit has been a mountain redoubt for the Beja people and a resort for Sudan's elite. It is a remote upland area that provides an escape from the heat of the lowland plains. The more reliable rainfall also makes it more suitable for agriculture than the surrounding arid lands, provided that what little fertile soil exists can be kept moist and protected from erosion.

The Sudanese Environmental Conservation Society (SECS) runs a catchment-based project in Ar Keweit to support local livelihoods. There are agricultural interventions such as extension for vegetable production, in addition to work on soil and water management. The project demonstrates sustainable approaches in all three elements considered in this report – improved resource sustainability, elements of cost recovery and strong community participation.

At the smaller-scale end of the interventions on resource management are works to control gully formation. The mid-sized check dam shown here traps sediment and provides extra storage for the well upstream of the dam. The largest of the three dams shown depicts a sand dam that has been heightened progressively, capturing the sediment behind it. The upstream area is flooded in the rainy season and crops are grown in the area available for agriculture created by the dam. These three structures – and many more small and medium-sized ones like them – lie on the same watercourse or khor, so that the water throughout the catchment is managed.

The project benefits from contributions of 2 SDG per person per year from people who live in the area. However, the greater input made by the communities is in their labour on communal schemes such as the construction of the bunds and banks. This contribution in cost and in labour gives the communities genuine ownership of the work, with SECS being held accountable to the communities through regular meetings. The area has received support from elsewhere to fund some of the larger pieces of infrastructure, but locally raised funds are being used for smaller works. There is a considerable impact of the work by the community for the community. It is notable that this scheme does not have a demand-led focus on handpumps and boreholes that abstract water, but a resource-based focus to maintain the reliability of hand dug wells and rainfed agricultural initiatives. The high degree of local ownership and accountability is an important factor in the effectiveness of the scheme.

Figure 3.1 Small-scale soil and water retention in gullies

Case Study 1: Ar Keweit

Figure 3.2 A sand dam for medium-scale soil and water retention in Ar Keweit – note the people and the goats gathered round the well under the tree in the middle background of the picture

Figure 3.3 A sand dam built in two stages for larger-scale soil and water retention in Ar Keweit. Note that the dam spillway on the far side of the dam, so that large floods do not overtop the dam and cause it to be washed away. The second stage would have been built after sediment filled up behind the first level of the dam wall. A large area for cultivation has been reclaimed behind the dam

Case Study 2: Hex Valley, South Africa

The Hex Valley is a picturesque agricultural area specialising in citrus and table grapes about two hours' drive out of Cape Town. The Hex Valley Water User Association manages water resources in one of the upstream sub-catchments within the larger coordination of the Breede Overburg Catchment Management Agency (BOCMA). With an average annual rainfall of 331 mm, water is a constraint on productivity in the area. The valley has an agricultural water demand of 31.5 million m3/year and domestic demand of 1.5 million m3/year. New demands include a new supply for the incoming migrant labourers who work seasonally at harvest time (0.6 million m3/year) and a growing demand for emerging black farming collectives (2.4 million m3/year). The water is managed holistically, according to IWRM principles

In 1998 a water master-plan was drawn up and used as the basis for dialogue with water stakeholders, so as to be able to bring the water demands and resources into balance. The masterplan sets out costed options for increasing supplies to meet different levels of demand. By commissioning a report that gives options on levels of supply and on the costs for these options, the water users are able to make informed management choices on the balances and trade-offs needed for sustainability in the system. The water user association employs an engineer to implement schemes to drive forward the technical solutions that have been agreed by the community on the basis of public consultations. It is interesting to note the level of management that can be achieved locally.

The arrangements for managing the water reflect the priorities for racial equality that came in when South Africa democratized in 1994. Sudanese delegates visiting the Hex Valley scheme were struck both by the social transformation that the new water governance arrangements enable and by the importance of the regulatory reforms in bringing about the improvements in water management and use.

The significance of good water management both for social equity and for the agricultural economy draws attention to its potential importance in efforts to build capacity in local water governance in Sudan.

BOCMA has the following clear mission statement, which evidently includes delegation to water user associations within the catchment: "to manage our water resources responsibly, through continuous engagement with all stakeholders and to devolve decision making to the lowest level for the benefit of all water users in the Breede-Overberg Catchment, including the environment".

Figure 3.4 Hex Valley Water User association

Case Study 2: Hex Valley, South Africa

Figure 3.5 A dam in Hex Valley managed by the community

Figure 3.6 Hex Valley in the Breede Overburg Catchment

Figure 3.7 Sudanese water resource managers visiting Hex Valley and the Brede Overburg Catchment Management Agency

Figure 3.8 The inland delta on Khor Abu Habil in North Kordofan is an important area for agricultural production

Khor Abu Habil rises in the Nuba Mountains in South Kordofan and flows into an inland delta in North Kordofan and White Nile State. The flow is from west to east. Nomadic pastoralists also need to cross this area from north to south around the time of the harvest, creating tension between them and the communities farming the land. Management of migration in a way that facilitates both livelihoods is essential for maintaining complementarity of the two production systems. The increasing water demand of the state capital, El Obeid, is an additional element for consideration in the development of a holistic approach to water management of this catchment.

Elsewhere in the Nuba Mountains, Concern Worldwide worked with communities near Kauda over a six-year period on catchment management with a strong livelihoods focus, developing results that reflected the sustained effort (see Case Study 3).

In North Darfur, the Wadi El Ku catchment management project is underway, with the end of the inception period coinciding with the initial drafting of this report. The project takes advantage of earlier efforts on community mobilisation and network creation undertaken by Practical Action. Community networks are well established for livelihoods, women's development and other important concerns. Under the new project, a network of natural resource management (NRM) committees is being set up under the auspices of the village development committees along the wadi. The project also brings together cross-government collaboration for integrated planning processes relating to the catchment. The community networks and the government committee meet in a wadi catchment management forum. The village development committees implement community based natural resource management schemes at the local level, which, when scaled up across the catchment, are intended to support an overall catchment management approach. The water demands for El Fasher are an important factor in Wadi El Ku, and so management of the engineering works for the city's supply needs to be integrated with the more community-based rural water management.

The accompanying report, "Towards Integrated Water Resource Management: International experience in development of river basin organizations" (UNEP 2014b), discusses different institutional arrangements for managing catchments.

Case Study 3: Kauda Catchment Management Project

Concern worked with communities and local project partners over a six year period in the Nuba mountains. They implemented a catchment management project in seven watersheds. The 2009 annual project review indicated that, by that stage, over 550 structures had been built or repaired, including check-dams, ponds, terraces and others. The works were implemented by local communities, with a combination of traditional community labour and paid work. Paid work included a sum for the labourer and a contribution to a community fund that was used to support livelihoods. Livelihoods were a key feature of the programme, which was undertaken in a way that supported both short- and long-term community needs. In addition to the contributions made by the community, external funding came from annual grants focussed on emergency responses, but these were used carefully to maximise benefits and enhance the efforts of local communities and organisations.

Given the continuity of the project over this period, the benefits of longer-term rehabilitation of watersheds were being achieved, with communities reporting that more water was available in the natural environment through the dry season, and could be exploited for domestic and agricultural use.

When describing the project to UNEP, the project manager stressed the importance of working at the upstream of the catchment towards the downstream, so that the benefits of buffered flows are achieved in all of the catchment as work is done. It is striking to see the alignment with natural processes right through the project implementation.

Figure 3.9 Check dams to retard water flow and "buffer" the availability of water in the catchment

Case Study 3: Kauda Catchment Management Project

Figure 3.10 Tree planting as part of the broader approach to natural resource management in the project

Figure 3.11 Support to livelihoods is a key element of work on natural resource management - improved livelihoods are the main incentive for communities to engage

4 Water supply in rural drylands

Figure 4.1 Community based natural resource management (CBNRM) has considerable significance for WASH as part of a broader approach to water management.

Key points:

- *Water supply in dryland contexts provides particular challenges for balancing the 'three Es' because of the variability in availability of water.*
- *A resilience framework for programming mitigates some of the challenges associated with long-term humanitarian approaches in drylands. Emergency situations require emergency responses, but where unsustainable "emergency" approaches are applied over a longer period, they may undermine coping strategies and prospects for recovery.*
- *Skills and approaches exist in the water sanitation and hygiene (WASH) community that could be extended to enhance a resilience approach to rural water supply in drylands. For example, Community Led Total Sanitation (CLTS) has much in common with Community Based Natural Resource Management (CBNRM), providing an existing foundation for community based programming.*
- *In Sudan, projects in Al Hawata and Al Khewei demonstrate what can be achieved with community engagement in rural water supply.*

Drylands are characterised as much by their variability as by their scarcity of water. Areas that are lush and green in the rainy season may be dusty and bare in the dry season. This description aptly fits the Sahelian belt running through Sudan. Crops are grown after the rains to make use of the moisture in the soil and nomadic pastoralists move their herds to follow the most nutritious pasture that greens up after the rains.

The integration of the 'three Es' (Economy, Social Equity, Ecology) brings the challenge of dryland water programming into clear focus.

- People may perceive a right to water, but this may not be available all year round in a given location due to a lack of water in the natural environment. If annual recharge to an aquifer fails in

the rainy season, then supplies may fail, notwithstanding the narrative of rights to water that development projects may have promoted. An exclusive narrative of rights may mean that expectations of what a project will deliver are beyond what the environment can support.

- In rural areas, providing a reliable water supply for livestock may be the key challenge, rather than water for people. In these cases, provision of a permanent water source may mean that livestock populations increase, and remain longer into the dry season than the rangeland can support. This may cause degradation of the rangeland. Responding in these environments requires a livelihood and natural resource perspective in addition to a WASH framework.

In emergencies, it may be appropriate to abstract water at a level beyond the sustainable yield and to subsidise this arrangement with external funding. However, two challenges emerge:

- The emergency response needs to be managed in a way that considers the implications of community practices of living and working with the natural environment.
- The exit strategy for the external support must enable a transition to water supplies within the sustainable limits of local funding and local resource availability.In short, a nuanced approach adapted to the context of resource scarcity and variability is necessary. Protracted emergency programming is in some ways a contradiction in terms. Where humanitarian assistance is needed for long periods, care should be taken to address the concerns of populations that share the same resources as those immediately affected by the crisis. On this basis, after the immediate emergency phase in which rapid provision of life-saving supplies is the sole focus, a move to a holistic approach to water management needs to be addressed alongside the humanitarian action.

This discussion has particular relevance to Darfur, where over 2 million people are directly dependent humanitarian support in the internally displaced person (IDP) camps, including WASH. The options for programming have been expanded by the welcome introduction of 'resilience' as a paradigm, placed alongside concepts of relief, recovery and development. Resilience places a greater emphasis on the capacity of communities and governments to manage the impacts of crisis.

There are many techniques in WASH and other established humanitarian disciplines that can inform the development of dryland resilience approaches. One of the most relevant is Community Led Total Sanitation (CLTS), in which a process of community problem identification, problem solving and action enables the development of a locally-owned process to address sanitation issues. This local ownership is particularly important given the behavioural changes involved in one community after another moving to eradicate open defecation. A related process that relies heavily on community mobilisation is community based natural resource management (CBNRM). CBNRM uses community problem solving and community planning to develop the management of natural resources on which the livelihoods of the community depends. It is encouraging to see some exploration of these different approaches beginning to emerge in Darfur.

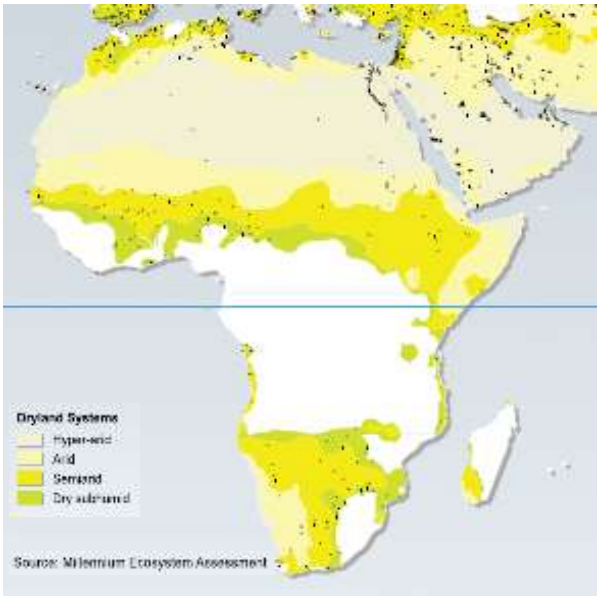

Figure 4.2 Location of drylands and urban areas in Africa and the Middle East

For government and donors of international aid, the extra emphasis on community ownership and decision making means a more complex narrative is needed with respect to value for money. Overall, this type of approach should be more cost-effective in solving the real problems that communities are facing with respect to water, although the headline numbers in a programme (e.g. the boreholes drilled at a given cost) may be less impressive. The emphasis has shifted towards enabling communities to resolve the problems they face over the longer term and away from provision of infrastructure per se. The greater need for staff time in managing these programmes should not be seen as boosting transaction costs, but as reflecting an increased focus on sustainability and a smaller spend on hardware.

4.1 Drylands and sustainable livelihoods

Drylands are areas in which the potential for water to evaporate outstrips the availability of water from rainfall - therefore what rain does fall evaporates quickly, leaving the area dry until the next rains. Rainfall is normally concentrated into a particular season, so drylands can appear relatively wet for short periods in the year.

The ratio of precipitation to potential evapotranspiration is known as the aridity index. Drylands are characterised by an aridity index of 0.65 or less, with the following subcategories: Dry subhumid 0.50–0.65; Semiarid 0.20–0.50; Arid 0.05–0.20; Hyper-arid <0.05.

Drylands are not just variable from one season to the next, but from one year to the next. They are classified as “disequilibrium environments”, because this inter-annual variability means that it is not possible to establish a consistent sustainable yield in production systems that applies from one year to the next. There is a constant rebalancing of how resources can be used within the available envelope in a given season or year.

Despite their overall scarcity of water, drylands are home to some 45% of the population of Africa. and arable farming are both practised, with increasing attention on livestock as aridity increases (see Figure 4.2). Drylands will therefore have significant potential relevance to the intensification of meat production to meet the accelerated demand identified above. However, cultivation is also important, as some “44% of all cultivated systems worldwide are located within drylands, especially in the dry sub-humid areas” (Millennium Ecosystem

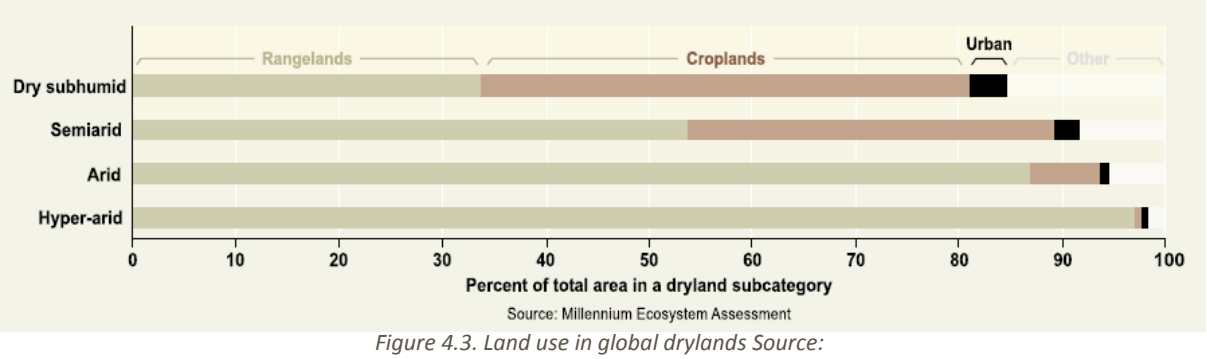

Figure 4.3. Land use in global drylands Source:
http://www.millenniumassessment.org/documents/document.355.aspx.pdf

Figure 4.4 Rangeland in the dry season and wet season in semi-arid West Darfur

Assessment 2005).

After the overall scarcity of water, the next most significant feature of water in drylands is its variable availability. The location of rainfall in season may be quite localised, and consequently the best place for nutritious grazing may be hard to find. It is this variability that has led to the traditional strategy of migration for grazing. Mobility represents an attempt to maximise the efficiency of livestock production by grazing on the most nutritious grassland that has greened up after local rainfall. The two figures below show the variability of rangeland between wet and dry seasons in the Dar Masaleet area of West Darfur.

Agriculture tends to be concentrated along ephemeral water courses – more reliable for water in that they capture rainfall over a large upstream area, and with the advantage of more suitable soils laid down from sediments transported down the water course over time.

There is an important self-regulating feature of traditional water technologies in drylands. Where water holes are dried up, then communities move to wetter areas. The water point recovers in due course, and use is at the sustainable yield over the long term. When cheap mechanised pumping technology becomes available, the aquifers may become over-abstracted, failing to recover on an annual basis. Where there is widespread uptake of pumping technology, aquifer depletion can be severe.

An additional risk in drylands is that the carrying capacity of the rangeland and of the aquifer may be different. Traditionally, depletion of either range or water would have been a push factor for pastoralists to move on. However, if a permanent water point is provided then this may attract too large a herd for the surrounding rangeland, and the quality

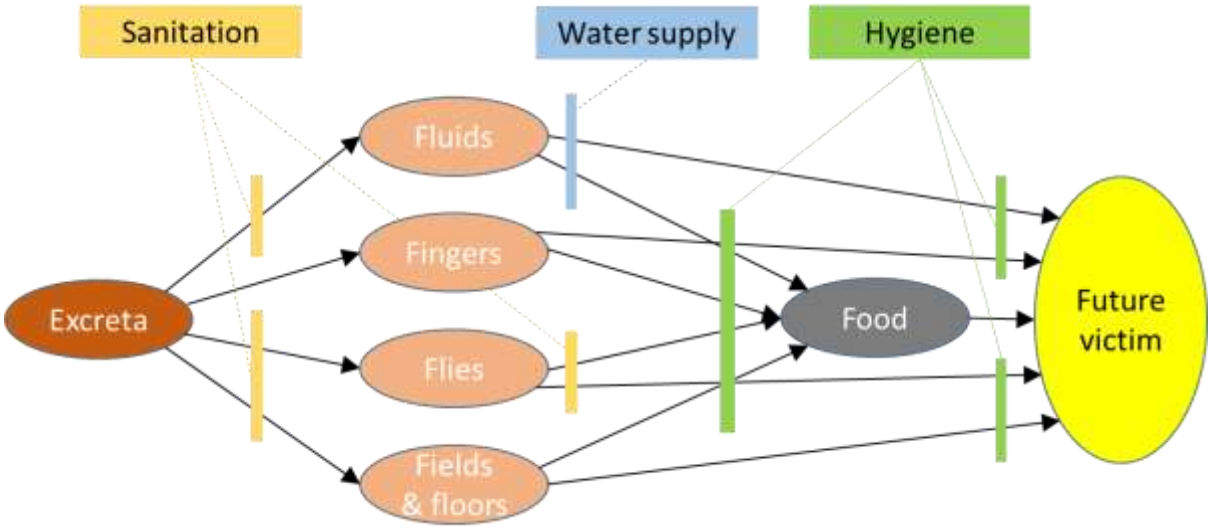

Figure 4.5 Graphical representation of the path of pathogens and the reason an integrated approach to WASH is required to promote health. Source: WaterAid.

of grassland is lost.

This shows that environmental sustainability needs to consider numerous resources – the viability of both range and water sources needs to be assessed to support grazing systems. For crops, a solution may be found to water scarcity through irrigation, but the nutrients in the soil must also be maintained.

4.2 Priorities for WASH

The emphasis on participation, and on financial and water resource sustainability, is entirely in line with the fundamental rationale for WASH programming. The basis of linking water, sanitation and hygiene promotion is that all three elements are required in order to cut pathways of pathogens that cause water borne diseases. These are shown graphically below.

By engaging the community on prioritisation of the project spend and on linking CBNRM with WASH programming, the balance of the three Es may be significantly improved. Rather than focussing on externally led provision of services, a community collective problem solving approach is strengthened. Achievements such as those in Al Khwei, Ar Kheweit and Hawata have set the standard with respect to what can be achieved with community based programming in Sudan. Similar initiatives need to be developed as part of the exit strategy for the major spend on emergency WASH programming in Darfur.

Figure 4.6 A simple hand-pump for water supply

Like all water programming, the work needs to be context specific. The exploration of the interface between emergency WASH approaches, CLTS and the emerging resilience-based programming needs to be supported. By way of example, a comparison could be made for a given project spend. In conventional programming, this could be used for a number of water yards and boreholes, latrines and some health and hygiene promotion activities. With a greater focus on resilience, a participatory problem analysis could be undertaken to consider why communities lack access to water. There may be a shortage of infrastructure, there may be problems with the supply chain of spare parts or there may be resource management constraints that mean water harvesting is the greatest need. The most efficient use of the money is likely to come where it is well aligned with the needs that the community identify and are therefore making efforts to address themselves. These are ways in which sustainability is promote d, both with respect to community ownership and with respect to economic efficiency.

The need for water resource sustainability created new challenges for the WASH community working through the crisis in Darfur. The region faces unprecedented population concentrations drawing water from the prevailing geology (fractured basement complex rock). Assessments of the geology indicated that perhaps as many as 800,000 of the 2 million displaced people would be vulnerable to groundwater depletion. Some of the most acutely vulnerable camps have had to develop alternative water supplies. Abu Shouk camp is now connected to the El Fasher urban water supply. In Nyala, Dereig camp ran dry after groundwater levels fell by 7m in 18 months. Tankering was used for a short time before a new borehole and a pipeline to the camp could be built. In order to mitigate the risks of groundwater depletion driving secondary displacement, new approaches to water resource management within the humanitarian response have been developed. In 2007-08 three reports were written at the time that the risk of groundwater depletion in Darfur's IDP camps was becoming clear.[20] There was a consistency in recommendations made in the key reports that

[22] Tearfund (2007) 'Darfur: water supply in a vulnerable environment' http://unep.org/disastersandconflicts/portals/155/countries/Sudan/pdf/dafur_water/Darfur%20Water%20Resources%20TF.pdf ; UNICEF/WES 'Darfur IDPs Groundwater Resources: Capacity, Depletion Risks & Contingency Planning' (2007); UNEP (2008) 'Water resource management in humanitarian programming in Darfur: The case for drought preparedness'http://postconflict.unep.ch/publications/darfur_drought.pdf

drove the changes in the humanitarian response. Some of the key elements included:

- Regular groundwater monitoring on a representative number of boreholes
- Household water use surveys to understand demand dynamics and enable contingency planning for water scarcity
- Improved borehole management, including a measurement of the elevation of the well-head flow meters on production wells, and good record keeping
- Good data management, including a unique identifying number for boreholes, archive of drilling records and mapping
- Both participatory and technical approaches to drought contingency planning

Progress has been made with databases to map elements of this data. Data collection is most efficient when the end users of data are kept in mind. Data is needed for three reasons:

- For resource management, including vulnerability assessments
- For demand management, including drought contingency planning
- To inform the design of boreholes if further drilling is undertaken

These reasons are discussed in turn below.

1. Resource management and vulnerability assessments

In order to understand how much water is available for abstraction, the main elements of good hydrological practice are required. Pump tests will be done when the well is commissioned in order to estimate the sustainable yield, and thereafter records need to be kept of the static water level in the well to determine if there are long-term patterns of depletion. For that, good data management is needed, including the use of maps with unique reference points for all boreholes. This approach assumes a consistent recharge of the well, which is unlikely. In order to understand the risks of the aquifer failing to recharge and replenish the water abstracted, there is a need to understand the pathway by which water comes into the aquifer.

In basement complex aquifers in Darfur, a common recharge path is the combination of direct recharge (rainwater falling onto the ground above the aquifer and seeping down) or, more significantly, lateral inflow from wadis. Mostly, Darfur has a radial pattern of wadis from the “water tower” at Jebal Mara, which has more rainfall than the surrounding area. Water flows out from Jebal Mara and is stored in the alluvial aquifers under and surrounding the wadi beds. This larger store of water is capable of recharging the poorer aquifers in the fractures in hard rock (basement complex) away from the wadi – if a hydraulic connection exists and the gradient is sufficient. Therefore, in order to understand the vulnerability of an aquifer it is necessary to understand whether it is connected to a source of recharge upstream, or whether it is dependent on direct recharge alone.

Dereig camp, which is situated on basement complex geology, adjacent to the watershed made by the airport road in Nyala, has no source of runoff for recharge, and so is dependent on direct recharge alone. (Or, in

Figure 4.7 The groundwater level in the community borehole is painted up on this post in Abu Shouk Camp to engage the community in water resource management and drought contingency planning and monitoring. This initiative was part of an "IWRM lite" approach in 2006-2008 (Photo: St John Day)

less technical terms: only the rain that falls directly onto the camp recharges the aquifer – no other water drains into the aquifer from elsewhere.) It was therefore not a surprise that this camp was the first in Darfur to suffer significant groundwater depletion. By contrast, the wells close to the wadi in Nyala are more productive, as they draw on the alluvial aquifer that overlies the basement complex in this area. Kalma camp is something of an unknown – the main wadi lies two kilometres to the south, and the respective levels of the aquifer in the wadi and in the camp, as well as the nature of the intervening geology, are not known. Therefore it is unclear whether this is a feasible route for recharge of the camp. An alternative source of recharge comes from Wadi Baba, but this has a smaller catchment. This type of analysis was used to identify which camps were vulnerable to groundwater depletion. The particular risk that emerged was that, if one or more years of poor rainfall occurred, then the camps dependent on direct recharge alone would be most vulnerable, followed by those with weak connectivity to alluvial aquifers.

These vulnerability of these aquifers illustrates the importance of understanding the recharge pathway for assessments of aquifers, and consequently the need for certain types of data, including well head level data.

2. Demand management and contingency planning

Understanding the demand for water is of equal importance to understanding the resource. This will enable planning based on projections of future demand, as well as contingency planning in case the resource drops and a reduction in demand is needed. In the case of Darfur's IDP camps, it is evident that a considerable proportion of water abstracted for distribution in camps is used in brickmaking or for sale outside the camp. These are important and highly relevant livelihood activities, but the same justification for providing free, drinking-quality water does not apply to them, as it does to emergency domestic supplies for displaced communities. It may be that some form of cost recovery (charging) for the water is needed, so that IDP lives can be supported but distorted water markets are not generated, and IDP return is not influenced by artificial water market subsidies.

An additional justification for understanding water demands is so as to establish a contingency plan for the risk of resource depletion or drought. There is a strong case for including community engagement in the task of undertaking the water use survey under the oversight of camp coordination structures. This survey will identify the water use profile under "normal conditions", and can be used to develop a reduced allocation in the eventuality that the resource is constrained. Since the survey is the basis of demand management measures, it is important that this, like the contingency plan, is "owned" by the community – to enable community led implementation (enforcement) of demand management measures as they become needed. Concurrently, plans for augmenting the resource in the event of drought should also be developed. Oxfam implemented a creative solution to the problem of communicating water resource scarcity to IDP camps in El Fasher, with the groundwater level painted onto a post adjacent to the pump. The community could see how this varied over time.

3. To inform future drilling

It is important that technical records of drilling, such as the borehole logs, are kept, to enable effective planning and well design for future drilling. Such records should include dry boreholes as well as productive wells. At this stage, effective management of databases is important. Databases work best when the data fields demanded are not exhaustive, but only include those that provide useful information for future purposes. The test of a successful data management programme therefore is not in whether the data is captured and stored – essential though that is – but whether the end product is useful and reliable for future users.

Success in these areas in Darfur has been patchy. Lessons have been learnt that can be used in other parts of Sudan. This work is also relevant in informing other humanitarian responses in dryland areas – Syria and neighbouring countries, the Sahel, Yemen and the Horn of Africa all face humanitarian crises or risks of humanitarian crises, for which enhancing best practice in this area would be relevant.

Case Study 4: Al Khewei

Northern Kordofan is famous for its Baobab trees (tebeldi), which have hollow trunks that have historically been used to store water, and for the lush green pasture after the rains. The area has many nomadic pastoralists and makes an important contribution to Sudan's national economy as a centre of livestock export.

At first sight, the Al Khwei water supply scheme looks fairly standard for rural Sudan. There is a borehole with an elevated tank that feeds tankers to take water to more remote locations. However, the shed behind the borehole holds a new generator and switchgear ready to be used in the event of breakdown. The explanation for this impressive spare parts management lies in the project oversight arrangements.

Institutionally, the Al Khwei water supply is a private company in which all of the water users are shareholders. As shareholders, water users have an interest in providing close enough oversight of the finances and management of the borehole to ensure effectiveness, but a light enough touch to ensure efficiency. The system works. Cost recovery is adequate to cover pre-emptive purchase of spares and a management team with capacity for the technical and clerical demands of the job.

There are no reported difficulties relating to resource efficiency. Interestingly, the use of tankers to supply bladders for livestock feeding also has benefits for management of the rangeland resources. If permanent watering points are used, then natural resources around the water point often become depleted. However, by using bladders, the location of watering livestock can be varied and the pressure on any given part of the rangeland reduced. Given the importance of livestock to the local economy, the maintenance of the natural resource base is an important foundation for a sustainable economy. The water is also tankered to remote areas that suffer from particular water scarcity, where it is used for domestic purposes.

Figure 4.8 Spare generator and switchgear for the Al Khewei water yard - ready for use when the current one needs repair

Case Study 4: Al Khewei

Figure 4.9 The Al Khewei water yard

Figure 4.10 A bladder tank being filled to take water elsewhere

Figure 4.11 Payment being made for filling a water tanker

Case Study 5: Hawata

The Hawata project in Gedaref state is an oasis of engineering technology and good management, despite being a surprising two-hour drive from the closest tar road. In the wet season, this area of black cotton soils may be cut off altogether. There is no reliable source of either groundwater or surface water, and so, unusually, a group of 50 villages with a population of over 150,000 is served by a network of some 300km of pipelines.

As in the Al Khewei system, maintenance is undertaken pre-emptively, and spare parts, including a standby generator, are held in the stores. This scheme, however, has considerably greater capital and operational costs. Fees are commensurately higher. The board of the project is comprised of 13 water users in addition to five technical representatives, and approved an increase in water charge to 5SDG per m3. It is interesting to note the value put on reliability of supply by the water users themselves. There was some opposition to this charge voiced in Gedaref, but the Wali of Gedaref State provided political leadership in support of the decision made by the water users. His role safeguarded the political independence of the scheme – this independence was cited as a critical success factor in the scheme, according to the project staff. One of the striking features of the project is the highly qualified technical staff employed, and the high degree of morale and motivation of the team.

Figure 4.12 Al Hawata water distribution and purification centre (hafir embankment on the right)

Figure 4.13 Swtichgear (L), pumping station (C) and tanker filling bay (R)

Figure 4.14 Al Hawata hafir: the original emergency programme to support refugees that the long-term development is built around

5 Urban IWRM

Key points:

- *IWRM is relevant in urban areas and has particular challenges with relation to the management of infrastructure, pollution and flood management. Catchments in cities need management for an integrated approach to water supplies, solid waste management and flood control. Useful examples exist in some developing countries where water user participation has enhanced urban water management.*
- *A number of Sudanese cities are facing significant problems of over-abstraction of groundwater and inadequate cost recovery. Support is needed to promote strengthening of urban water management for sustainability. There are cases such as El Fasher, El Obeid, Nyala and Kassala where urban water demands are potentially in competition with important water resource needs for agriculture. Port Sudan faces particularly severe challenges for sustainable water management.*
- *Examples from Durban and Port Elizabeth demonstrate innovations in managing water resources for cities, particularly in drought conditions, which are relevant to the context in Sudan.*

Urban water resources management is a pressing concern in Sudan as a result of the significant growth of Sudan's cities. Consequently, there is increasing pressure on aquifers and wadis that supply urban areas, which in many cases are also used for agriculture. Kassala, El Obeid and El Fasher all fall into this category. IWRM is a tool that is used in many countries in urban contexts to improve sustainable water management.

In urban contexts, water managers must work with other sectors to develop an integrated approach to urban planning and management. There are particular challenges around waste management and flood management that are important in urban contexts. Towns and cities also see higher levels of revenue and greater costs incurred in the event of flooding or pollution.

In Sudan, the interface between solid waste management, urban drainage and water supplies hinges on the practice of refuse disposal during the dry season in small water courses (khors), which are flushed out when the rains come. This has health risks, both from the waste that lies in the streets and from the pollution of water used to flush out the waste. In some cities, such as Nyala and Kadugli, there are shallow aquifers and open wells, which are an important water source for the urban population. These aquifers are particularly vulnerable to pollution.

Leakage control is an important first step in increasing water supplies with aging infrastructure. As pipes are repaired, however, the amount of water saved for the money spent decreases, so a tradeoff in the "economic value of leakage" is reached. In locations where water is scarce and consequently expensive, a greater effort on leakage control will be made. In this way, resource efficiency and economic efficiency are tied together. In addition to controlling leakage, other forms of unaccounted-for water, such as illegal connections, need to be controlled. The informal water market may at first appear attractive in having lower bureaucratic costs and providing income for vendors and transporters; however, the reality is often much higher prices and poor quality. In Jakarta, vendors sell water from a cart at up to 50 times the cost of the mains supply (Fournier et al 2011, UNEP 2011).[21]

In cities, water governance is more closely aligned with a vertical service-orientated approach, in which consumers pay a fee and the utility provides the water or removes the wastewater. This is different from rural contexts, which put more emphasis on collaboration amongst users – horizontal relationships. Examples are emerging in different countries, however, where collaboration amongst stakeholders is also improving water management in urban contexts. In Malawi, wealthy residents

[21] In Karachi, Global Water Partnership (GWP) estimates that private vendors charge up to 12 times public supply charges (Bahri 2012).

collaborate in taking their supplies from a single source and paying for it collectively. In Jakarta, a similar approach is used to supply some informal settlements (Fournier et al 2011, UNEP 2011). In Karachi, Pakistan, a city under considerable water stress, a partnership exists between the city and water users to tackle urban water problems collectively. The Karachi Water Partnership has promoted accountability in the sector and undertakes specific local action, such as ensuring provision of water and sanitation in schools and promotion of water conservation practices (Bahri 2012).

Case Study 6: Durban, South Africa

Figure 5.1 Durban water and sanitation zoning map *Figure 5.2 Durban water infrastructure planning map*

Figure 5.3 A waterless toilet block increasingly used in Durban. The pan separates solid and liquid. Two chambers store solid waste: one is active, the other is being composted and can be safely emptied

Case Study 6: Durban, South Africa

The Sudanese delegation visited Durban two weeks before the 2010 World Cup and enjoyed the hospitality of a city well prepared for visitors. In 2014 the city was awarded the prestigious Stockholm Water Industry Award as the “most progressive water utility in Africa".

The analytical framework of this report would resonate strongly in Durban, given the centrality of the effort to close the gap between water demand and the available resource, to manage the budget for water investments and to ensure that the poor receive a reliable basic service.

The key diagrams in the planning documents are shown on the following page. The water balance shows what the projected water demand is in the coming years and what projects will be needed at what time in order to meet this demand. Cost estimates have been put to these projects, and their selection is integrated with the financial planning by the city authorities, to ensure that revenues cover the projected expenditure. An important element of the plan is that there is more than one demand projection. This reflects the overall demand at current levels of usage and on the basis that “demand management” is successful. Such management includes efforts to reduce leakage, reduce use, improve recycling and reduce wastage of water.

One of the most striking comments made by the authorities in Durban was that: “Since water is scarce, we believe it is too valuable to be used to transport human waste, therefore we are not extending the sewerage network beyond the existing areas served”. “Eco-sanitation” is a vital part of Durban’s water strategy. New latrines in Durban use a technology that separates solid from liquid waste at source so as not to require connection to a sewerage network. Durban puts a considerable emphasis on innovation, monitoring and research in its water management.

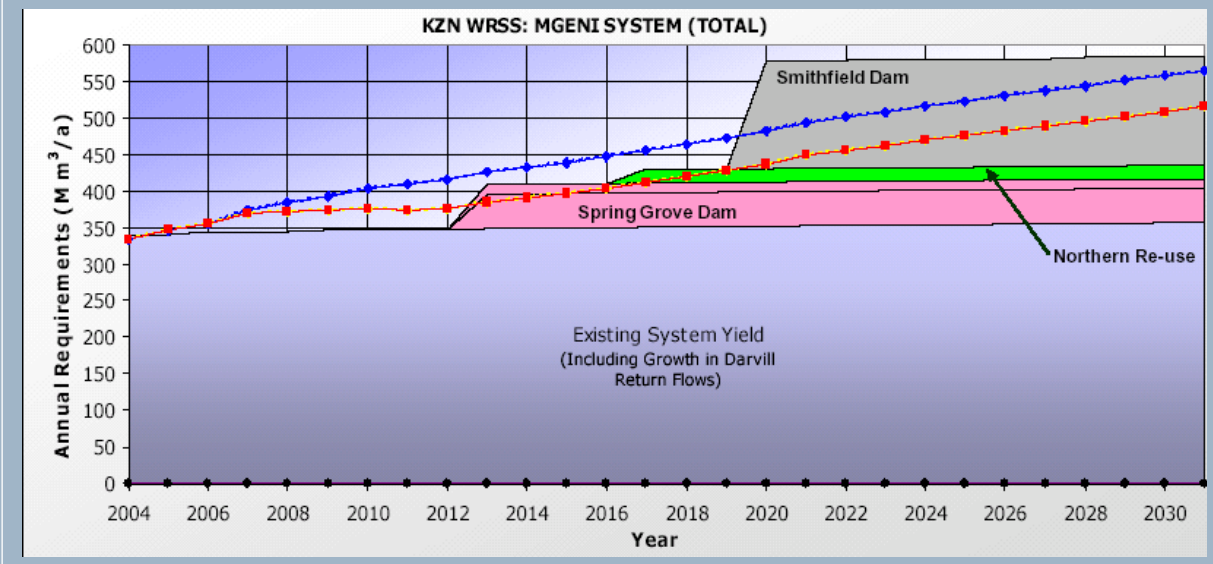

Figure 5.4 Durban Water Demand Projection and Construction Programme. The lines show demand projections and the blocks show the projects that will be constructed to meet this demand. Note the two lines – the lower one assumes the successful implementation of demand management measures

5.1 Sustainability challenges in mid-sized cities in Sudan

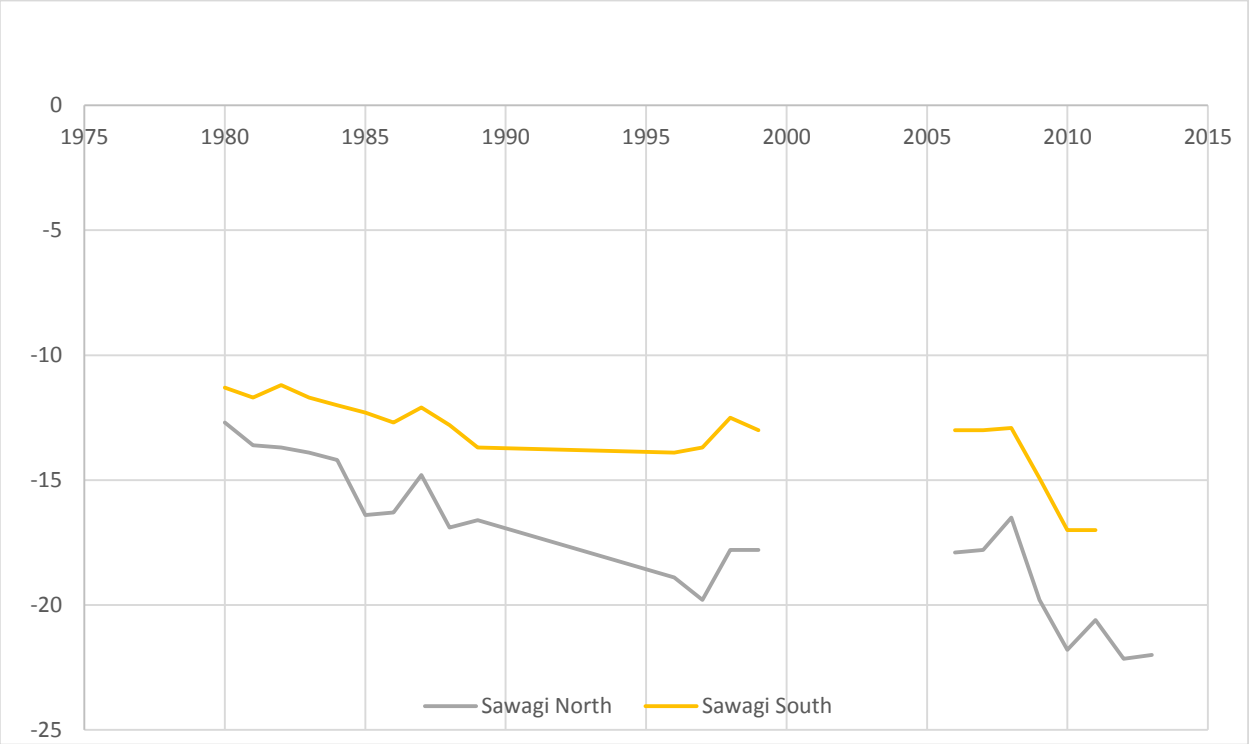

Figure 5.4 Groundwater levels (m below ground level) in the Upper Gash Delta near the city of Kassala

Kassala has an impressive programme of investment for water supply and plans in place to ensure that ongoing costs will be met through revenue collection. The Director General of the State Water Corporation (SWC) is clear that a coordinated approach with political leadership from above has been essential to the success of this work. Another important element is the support of Japan International Cooperation Agency (JICA), who are providing finance for capital investment and matching this with an extensive training programme for SWC staff. This sustained commitment to capacity-building is bearing fruit.

Kassala lies at the upper end of the Gash Delta – an inland delta running for around 100 km downstream of the point that the river Gash comes out of the mountains and crosses the border from Eritrea into Sudan. Significant effort has been put into establishing a catchment-based approach to water allocation. At the core of the scheme is the idea that farmers have access to both an upstream and a downstream patch in any given year, so the risks of variable flow in the river can be mitigated. The scheme has not been effective, in part because of the challenges of cutting across different governance structures, including formal government, traditional leadership and local management of the scheme. The absence of a holistic approach to managing this resource is regrettable, as both the urban supplies and the potential for agriculture rely on the ongoing availability of the resource, notwithstanding the variability in flow, which has the potential to become more volatile under the influence of climate change.

The Groundwater and Wadis Unit is not well integrated into the urban water management group in Kassala. As a federal rather than a state organisation, it would need to take a proactive approach to engage at state level. The provision of clear data indicating the state of the resource would clearly add value in the effort to ensure a sustainable supply. The figure below indicates that, in the upper part of the catchment, abstraction is greater than the

Figure 5.5 Tankers routinely discharge wastewater to this rangeland area outside of El Obeid

sustainable yield, so there is a degree of urgency in the endeavour to raise the profile of resource management.

In Gedaref, urban supplies are facing a particular challenge as a result of the low level of supply and low revenue collection. City supplies have fallen into a spiral associated with under-investment. The charges in 2013 were 1.56 SDG/M^3, but production cost was 3 SDG/M^3. Raising the charge is politically difficult, given the low level and intermittent supply. With water in pipes for only part of each day, metering is unreliable due to the air blowing through pipes.

In 1997 the Gedaref State Legislature established the Gedaref State People's Organisation as a voluntary body to assist with development and oversight of water management. The group had an assembly of 43 people representing different interests within the state. It worked in partnership with state authorities and oversaw an improvement in the urban water supplies and a number of rural water supply projects in the state. Regrettably, the group has been disbanded and former members are not in a position to contribute to the resolution of the current political challenges relating to urban water supplies. Nevertheless, it provides an example in a Sudanese context of how participation can promote social equity.

Perhaps the city in Sudan facing the greatest urban water supply challenge is Port Sudan. However, some steps could be taken to boost the supply without major investment. Kassala has demonstrated the importance of state-level political leadership for reform of the water sector, and significant headway could be made in Port Sudan. In the summer of 2013, urban supplies had dropped to low levels and demonstrations were occurring in protest. Political leaders sent a delegation to Khartoum requesting financial support for a pipeline to Port Sudan from the Nile. This pipeline would pump freshwater very long distances to a coastal area, in stark contrast to the model of desalination established in many Gulf Arab countries, which have experience of piping desalinated seawater far inland.

Water in Port Sudan comes from three sources: the Wadi Arbaat dam, some local boreholes and desalinated sea water. The new dam is upstream of the old dam. There is evidently a considerable amount of evaporation coming off the lower reedbed. The leakage from the upstream dam is estimated at as much as 4,000 m3/day. This could be collected and pumped to augment the supplies in the town.

There are four desalination plants in Port Sudan, each with a capacity of 5,000 m^3/day, but these are managed from Khartoum rather than being under local control. During the

summer of 2013, production had dropped to some 3,000 m^3/d, with 17,000 m^3/d capacity requiring maintenance. In order to fund repairs, finance needs to be requested externally rather than coming out of the State Water Corporation revenue collection. This introduces an inefficiency that undermines the ongoing maintenance of the plants.

Solid waste management in low-income cities

International experience illustrates that it is not difficult to establish waste management and recycling initiatives, but it is harder to make them financially self-supporting. Consequently, numerous failed schemes exist. Central areas may be kept clean through focussing on areas with higher revenue potential and cross-subsidisation from other sources. Key success criteria for solid waste management would include the core issues of:

1. Public education and awareness raising;

2. Cost recovery mechanisms;

3. Legislation, enforcement and government capacity;

4. The adoption of appropriate technology – compatible with the local skills base and the availability and affordability of spare parts for routine repairs and maintenance.

Informal waste recycling has an important role, not least as last-resort income generation for those otherwise facing destitution. Unlike informal water supply, this does not involve the risk of raising costs for others facing extreme poverty. Therefore, new waste management initiatives in low income contexts should first consider enhancing and improving existing structures – and in so doing elevate the health, safety and welfare of those individuals already involved within the sector, many of whom tend to be young children.

Source: Based on UNEP expert mission report on solid waste management and recycling in Khartoum, November 2011

Case study 7:
Drought management in Port Elizabeth, South Africa

Figure 5.6 Water scarcity awareness raising at a school in Port Elizabeth

Such remote management stands in contrast with the success stories listed in this report. There is potential to enhance productivity by empowering local managers to organise maintenance. Capturing a greater proportion of the leakage from the dam and improving the performance of the desalination plants could be significant steps towards enhancing the reliability of the water supply.

Nyala faces immense challenges relating to water supply, given the rate of growth of the city as a result of the conflict. It is difficult to get accurate figures on population, but it may have tripled in size from the pre-conflict population of 400,000. The city lies on basement complex geology, with a large wadi running through it. The alluvial aquifer is shallow upstream of the town but deeper downstream. There is a significant amount of farming downstream, as well as the large IDP camp of Kalma. Solid waste management and flooding are both problems that affect the city, with the fresh floods of new wet seasons flushing trash out of the city's streams. The principal challenge, however, comes in the late dry season when the alluvial aquifer is depleted. Pumps and hand-dug wells run dry in large numbers and the price of water rises. Private wells are difficult to regulate.

Proposals have been made for a catchment-based approach that would address both the management of the aquifers for the urban supply and the agricultural water demands in the area south of the city. An important element of this would be to control the groundwater pollution risks associated with the shallow aquifer in the town, so an integrated wastewater and solid waste management approach would be essential.

6 Broadening the view

Key points:

- The concepts of 'blue water' and 'green water' are introduced. The report has focussed on blue water, which is water that is readily accessible for use. Green water is water in the environment and hard to divert to other uses, but has considerable significance for agriculture.
- Green water requires greater attention in water management, as it is the water used in rainfed farming and pastoral production systems, as well as being an important component of water used in irrigated agriculture. Enhancing the productive use of green water is an important goal for increasing agricultural productivity in Sudan.

6.1 Blue water, green water and agricultural productivity

The focus of the report has been on water in aquifers, surface water and water being managed in pumped systems, pipes and reservoirs. This section considers water in the soil that cannot be drawn out for engineered use, but is essential, for example, for food production. This water is known as green water, in contrast to blue water, which has been the focus of the report so far

Green water can be defined as referring to "rainwater stored in soil or vegetation, which cannot be diverted to a different use. Blue water is surface and groundwater which can be stored and diverted for a specific purpose" (UNEP 2011; Molden 2007).

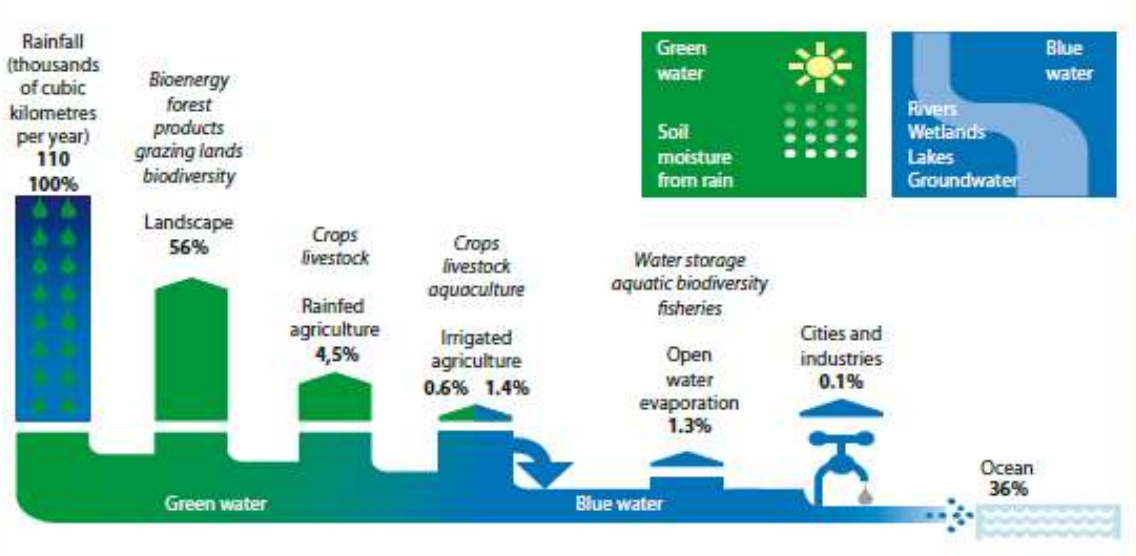

Figure 6.1 Green water refers to rainwater stored in the soil or in vegetation, which cannot be diverted to a different use. Blue water is surface and groundwater which can be stored and diverted for a specific purpose

The importance of green water becomes clear given its significance to food production, through rangeland for grazing and rainfed agriculture. At present, irrigated land accounts for only 3% of staple cereals in sub-Saharan Africa (Hoff et al. 2013). Clearly, expanding irrigation has a role in increasing food production in Africa, but the costs are high. There is also considerable scope to improve the management of green water in both livestock and food production, so as to enhance agricultural production and productivity.

In a seminal paper on the potential role of green water in agriculture in Africa, Rockström et al (2009) state that:

"A comparison between blue water shortage and combined blue and green water shortage shows the majority of the extensive areas that are characterised by chronic blue water shortage actually have an adequate overall supply of water to meet the water required for producing the standard diet. This includes most of those areas in sub-Saharan Africa that are blue water scarce."

Given the importance of green water, it emerges as a key area for further exploration in the IWRM agenda in Sudan, with three important priorities.

As discussed above, the first is with respect to food security and the potential to increase yields by improved water management. In essence, the aim here is to capture water and enable it to infiltrate and be used for food production before it evaporates, or runs off to evaporate later. Principally, this refers to rainwater harvesting, including use of the following techniques (based on Ngigi 2006):

1. In-situ water conservation: infield tilling and planting regimes such as agroforestry, contour trenches to reduce runoff and soil loss on steep slopes, etc. (controlling green water).
2. Micro-catchment approaches such as half-moon shaped bunds (controlling the green/blue water interface).
3. Flood diversion systems for spate irrigation / flood based farming (controlling blue water)
4. Run-off based systems with local storage, such as sand dams, tanks and hafirs (controlling blue water).

Recent research undertaken in Ethiopia stresses the importance of integrated approaches to agricultural, livelihoods and rainwater harvesting extension work (Gebregziabher et al, 2013). The research indicates that there is interdependence in the effectiveness of different rainwater harvesting techniques – a factor that needs to be built into efforts to support agricultural livelihoods in a catchment. The developing programme of work in the Wadi El Ku catchment reflects this also – community based natural resource management and support in areas such as the marketing of agricultural produce are needed, in addition to water. The role of women should also be highlighted, given their important role both in water management and in farming. This was reflected in the results of the research on uptake of rainwater harvesting in Ethiopia, with membership of women's associations having a significant effect on the uptake of some approaches.

Secondly, conceptualising water in the environment in this way also adds understanding to the significance of pastoralism. One test for pastoralism as a production system is whether, by enabling mobility of livestock, the efficiency of capture of green water in the food value chain is enhanced. The use of remote sensing and of modern livestock tracking systems means that the efficiency of the livestock production system can now be assessed more thoroughly. Further research in this area has significant potential for enhancing Sudan's livestock sector

A third important implication of the significance of green water is in catchment management projects. If only blue water is considered, the scope for win-win scenarios is diminished, as water used upstream is unavailable downstream. However, if both upstream and downstream communities collaborate on enhancing efficiency of use, the potential for overall increases in efficiency is enhanced. This extends the degree of common endeavour within the catchment management scheme.

Rainwater harvesting

1. In-situ water conservation

Agroforestry combines the use of trees and of crops to enhance soil and moisture retention for crop growth. The inter-planting of crops that cover bare ground reduces the erosive force of rain and enhances soil retention. Appropriate tilling depends on soil type and slope. Hard, crusted soils may need to have the surface broken so as to improve infiltration of water. Deep tilling may be disadvantageous, as it can break down the structure of the soil and make it more prone to erosion. Deep tilling may also undermine the biological content of the soil by destroying soil profiles that enable growth.

Figure 6.2 Fanya Juu terracing involves throwing the excavated material up the slope. This figure shows the initial profile (Left) and how it develops over time (Right) Source: Critchley et al. 1991)

Cross-slope barriers may be made from the soil of the slope from rock or with vegetation such as vetiver grass[22]3. When they are made from soil, then the profile may develop over time. An example is the "Fanya Juu" type terracing which starts with a trench with the fill thrown uphill that after some years develops a terraced profile (see Figure 6.2). In each case, the barrier retards runoff and catches sediment. Over time, the slope takes on a stepped appearance and the flatter gradient between steps reduces runoff and erosion, enhancing infiltration. Where hillsides are stepped to make strips of horizontal ground, these are known as bench terraces .

Figure 6.3 Bench terracing in Afghanistan. A rocky slope has been cleared and stabilised to provide flat land for use

[22] FAO provides more information on these approaches: http://www.fao.org/docrep/014/i1861e/i1861e07.pdf

[23] http://www.fao.org/docrep/006/ad083e/ad083e07.htm

Figure 6.4 Trenching and tree planting on a slope in Afghanistan to retain soil and slow runoff on a steep slope

2. Micro –catchments:

Figure 6.5 Micro-catchments at the field level in use in South Darfur (Source: Nyala Water Harvesting Centre)

Figure 6.6 Half moon catchments to concentrate water that falls on a slope so it is useful for producing plants (Source: Nyala Water Harvesting Centre)

3. Flood diversion / flood based farming

Figure 6.7 A spillway on the water spreading dam in Um Barunga in Darfur. This structure captures a large pool of water on the upstream side (the left in this photo). During the wet season this water can be used to irrigate a crop downstream of the dam. As the flood water recedes, a crop can be grown on the upstream side of the dam (Source: Practical Action)

Figure 6.8 Flood farming in the Khor Abu Habil in North Kordofan. Regular maintenance of the earthworks that distribute flood water is required. This necessitates suitable institutional arrangements so that water distribution and responsibilities for maintenance are equitable

Figure 6.9 A traditional approach to rainwater harvesting in the Batinah plain, using brushwood that traps windblown sand in the dry season to create a bund for managing overland flow in the wet season

4. Run-off collection and storage

Figure 6.10 A newly built sand dam on the Merue River in South Kordofan. Sand will build up behind this dam and water will be stored in the sand through the dry season. A newly heightened dam can be seen in the back ground. This makes a cascade of five dams that considerably increase availability of water through the dry season (Source: SOS Sahel)

7 Capacity building and policy development

Figure 7.1 Decision makers from Darfur and federal undersecretaries from two ministries in Khartoum visit the houses of parliament in Cape Town in 2010 to discuss the role of legislators in water resources management

Key points:

- IWRM is not new in Sudan, and a number of important initiatives have been made by a diverse range of actors. The impact collective impact of these initiatives is undermined by weak coordination and institutional memory, notably amongst international organisations in Sudan. The impact could be enhanced by improving coordination and complementarity of the approaches.
- Work undertaken for a policy dialogue on IWRM in 2012-13 established five thematic working groups. These groups have potential to enhance coordination on IWRM, and can be linked with UN agencies by matching the mandates of the groups and agencies.
- The Groundwater and Wadis Unit in the Ministry of Water Resources and Electricity has established a new database for hydrological information in Sudan. This achievement now needs engagement from across the water sector to ensure the work is used for the benefit of commercial, community and domestic water development in Sudan.
- The new hydrological management system can usefully be developed by adding mapping data and identifying regions in Sudan with different characteristics for resource development. In some areas catchment-based approaches will be a priority, in others urban, and elsewhere different dryland water development protocols will be appropriate. A collective and coordinated approach to establishing guidelines for development in different hydrological contexts would be the appropriate next stage of the IWRM initiative on which this report is based.

Reviewing initiatives on IWRM

The development of IWRM in Sudan is progressing, with a number of different initiatives that show significant complementarity, but weak coordination. The initiatives are reviewed here, and the case is then made for increased coordination to enhance the impact of the work being done. Sudan pledged to implement IWRM in Cape Town in 2005. Draft policies for IWRM and for WASH exist from 2007 and 2009, respectively, indicating the technical engagement on these issues. WASH policy development underwent an extensive consultation process, providing an important basis for its adoption. The IWRM draft policy had a more limited consultation process, and the IWRM agenda has moved on with the subsequent awareness-raising consultations and projects since 2007. Important initiatives that can be drawn on to demonstrate experience in IWRM include:

- El Gash – catchment management for the inland delta
- Wadi Nyala – effort to manage the water resources in the wadi
- Nile Basin Discourse[24] – civil society contributions to the Nile Basin Initiative
- Eastern Nile Technical Regional Office (ENTRO)[25] - work on integrated watershed management.

In addition, UNEP's work on sustainable development and climate initiatives has more to contribute on participatory ecosystems-based approaches to natural resource management. Important initiatives include both the National Adaptation Programme of Action (NAPA)[26] and the forthcoming National Adaptation Plan (NAP).

The Drinking Water and Sanitation Unit (DWSU) of MWRE is currently promoting an initiative on water quality, building on the work of the African Ministers' Committee on Water (AMCOW) and UNEP at the Africa Water Week in Senegal in May 2014. The initiative will promote water quality monitoring by taking a holistic approach from water resources through to water users, based on water safety management approaches. DWSU have highlighted the need for this initiative to be built into the larger effort to harmonize the water sector within an IWRM framework.

There also is academic interest in IWRM: for example, with the Sudan Academy of Sciences running an IWRM Masters degree. Civil society groups with an involvement in IWRM include the Sudan Water Partnership (SWAP)[27], affiliated to the Global Water Partnership, and the Sudanese Environmental Conservation Society (SECS)[28]. Within the UN, IWRM is of particular interest to the following agencies:

- IFAD has run catchment management and CBNRM work in El Gash and in Khor Abu Habil.
- FAO features IWRM in its strategic planning documents and has run small-scale catchment management work in complex contexts, such as Wadi Bulbul, with a livelihoods and peacebuilding agenda.
- UNDP supported the work on the NAP, which made recommendations for increasing catchment management work, also featured in UNDP's follow-up planning.
- UNOPS has worked in partnership with UNEP on water harvesting structures in Darfur in support of an overall IWRM strategy, taking it forward with work on urban and rural water supplies aligned with IWRM objectives in these contexts. To this end, UNOPS commissioned a report on the social dynamics of water supply in Nyala: "Pipelines and Donkey Carts" Nicol et al. 2012.[29]
- UNICEF has a focus on WASH programming and sees this as complementary to IWRM, engaging in activities such as groundwater

[24] See http://www.nilebasindiscourse.org/
[25] See http://entroportal.nilebasin.org/default.aspx
[26] See http://unfccc.int/adaptation/workstreams/national_adaptation_programmes_of_action/items/4583.php
[27] http://www.gwp.org/en/GWP-Eastern-Africa/Mission-Vision-and-Values/Country-Water-Partnerships/Sudan/
[28] See http://www.secs.org.sd/
[29] See http://www.odi.org/publications/6404-nyala-darfur-sudan-water-access

monitoring and drought contingency planning in partnership with UNEP.[30]

- UNEP focuses on IWRM both in national level programming, which supports policy and institutional strengthening for IWRM, and through the implementation of a major catchment management project in Darfur: Wadi El Ku.[31]

Government IWRM consultations, the Sudan Integrated Environment Project and the IWRM Sudan South Africa Exchanges

The collaboration between Sudan and South Africa began with the two study tours already mentioned in this report. The vision documents produced on the tour are given in Annex 1. The key principles identified on these tours include:

- Effective collaboration between organisations, based on clearly defined mandates and responsibilities. Policies, strategies and law should be aligned for effective implementation of water supply and water resources management.
- Management of water resources along catchment boundaries.
- Water user associations informing water sector planning through representative and well-managed water boards and consultation processes. WUAs should be formed progressively at state, catchment and sub-catchment level.

The study tours are significant because of the delegates who attended. The first tour was focused on technical participants, and included, for example, the Directors General of the State Water Corporations of the three Darfur states. The senior government representative was the DG of the Groundwater and Wadis Department of the Ministry of Irrigation and Water Resources. The wide representation of the three Darfur states on this tour (see delegate list on the vision statement in Annex 1) meant that the tour made a substantive contribution to the development of a shared vision for IWRM in Darfur. At the request of the delegates from the first tour, UNEP coordinated a second tour with senior decision makers at ministerial level from the three Darfur states. From federal government, the Undersecretaries of both MIWR and MEFPD attended the tour, marshalling political leadership to back the vision that the technical delegates had proposed. Indeed, the vision statement from the second tour opens by endorsing the approach previously articulated by the technical delegates.

Within South Africa, the tours were hosted by the Water Research Commission, who coordinated both the technical programme and the logistical arrangements for the visits. A critical element of follow-up to the tours was the ongoing collaboration, including return visits to Sudan. The Director of Water Resources at the South African Water Research Commission, Ms Eiman Karar, holds both Sudanese and South African nationality, and therefore had a unique opportunity to communicate across the two contexts. Ms Karar made follow-up visits to Sudan on four occasions between July 2010 and January 2013. Notably, she made presentations in the National Council Assembly in December 2011 and in state legislatures in North and South Darfur in July 2010, as well as speaking at the Darfur International Water Conference in July 2011.

Follow-up to the tours in Sudan included the development of a joint concept note for the take-up of IWRM amongst MIWR, MEFPD and UNEP, with a formal ministerial endorsement (see Annex 2). The proposed approach was that there should be three levels of activity:

1. To support MIWR in the formulation of policy and strategy for IWRM, with a focus on non-Nile water resources.
2. To implement participatory catchment management in a number of degraded wadi basins in Sudan on IWRM principles
3. To support institutional strengthening of IWRM stakeholders with a particular

[30] See http://www.unicef.org/sudan/wes.html
[31] See http://unep.org/disastersandconflicts/CountryOperations/Sudan/News/CatchmentManagementProject/tabid/132997/Default.aspx

focus on the Groundwater and Wadis Unit.

These activities have duly been taken forward. Over time, other organisations, such as the Higher Council for Environment and Natural Resources (HCENR), UNDP and UNOPS joined the collaboration represented by the concept note.

The first objective was taken forward with a process of awareness raising and policy dialogue across 11 federal government ministries in December 2011 and December 2012. This dialogue was hosted and led by MIWR. A key element was the establishment of five working groups with the following themes:

1. Food Security
2. Knowledge, Research, Advocacy, Media
3. Energy and Economic Development
4. Water Supply
5. Environment

The thematic groups worked to develop technical papers on the basis of consultations across government with the ministries and organizations they represented. This work continued in 2012 and 2013. The status in 2016 is that a final workshop is required for the review and endorsement of the technical papers the groups have developed. Consultations in 2014 indicated that institutional changes meant this process has taken some time but that interest exists amongst stakeholders to explore these issues further.

Within Darfur, a working group was established for policy reform on IWRM, based in Nyala. This led to a wider process of dialogue around natural resources, which shifted attention to land management following a further study tour to Kenya and Tanzania on land and natural resources. The outputs of this tour and the consultations across the five states of Darfur are described in the accompanying UNEP report, "Natural Resource Management & Land Tenure in the Rangelands. Lessons Learned from Kenya and Tanzania, with Implications for Darfur" (UNEP 2014d).

The second objective of the joint concept note has made substantive headway. There is growing interest in implementation of catchment management schemes across Sudan from national and international stakeholders. Notably, the Wadi El Ku project in Darfur addresses this goal. UNDP, FAO and IFAD also aim to promote catchment based approaches.

The third objective is addressed through the partnership between GWWU and UNEP. GWWU has established a national coordination unit for IWRM. An important step has been the development of a new database for hydrological management in Sudan. The database is aligned on hydrological boundaries, thereby significantly improving national capacity to manage water resources in an ecological and integrated manner.

The way forward

It is evident that opportunities exist to enhance coordination of the different approaches to IWRM in Sudan. The three elements of the concept note provide a useful basis for action on this work. Notably, the collaboration on national dialogue and policy formulation has potential to be taken up again. There are natural alignments between UN organizations and the working groups that could form the basis of a coordination mechanism on IWRM. These would be:

1. Food Security – IFAD, FAO
2. Knowledge, Research, Advocacy, Media – UNESCO
3. Energy and Economic Development - UNDP
4. Water Supply – UNICEF, UNOPS
5. Environment – UNEP

This arrangement would enhance the development of a strategic approach to water resources management in Sudan.

In addition, the second objective has further scope. Work by UNOPS in the water sector continues to expand. Urban IWRM is an important area for uptake. Other organisations are pursing IWRM-based initiatives as described above.

The third area of collaboration – capacity building of GWWU to manage the technical

elements of IWRM – needs to build on the achievements so far, including both the database and the data collection and dissemination undertaken at field level in Darfur. The objective here must be to provide the information required by organisations wishing to develop water resources for productive use. Databases are only as useful as the information they disseminate.

An approach for consideration would be to:

- Provide a map that shows hydrological boundaries for the units in the database.
- Group these as water management areas according to catchment, ecological and social contexts. In some cases, the catchment will determine the appropriate management unit; in others, alternative factors will determine the priority. For example, sometimes urban considerations may prevail, while elsewhere – as in the wide flat cotton soils of Gedaref – catchments are poorly defined, and different management areas are more appropriate (as demonstrated by the Hawata project).
- Work with local stakeholders and technical experts to establish water development protocols for the different water use areas in the map. This effort could be undertaken in collaboration with the water quality initiatives proposed by DWSU. Water quality and quantity are inextricably linked, and thus should be addressed together.
- Establish ongoing management of these water use areas.

The approach described above represents a balance between ambition and achievability. Coordination will enhance the capacity of aid actors to provide complementary efforts to support Sudan's water resources management. Donor coordination should be highlighted as a key step. Government coordination is likewise a priority to enable all ministries with an interest in water to fulfill their own mandates.

A pragmatic attitude is required. For example, in the area of participatory approaches, existing water management arrangements should be enhanced where possible, rather than implementing a shift to fully decentralized models, at the risk of failure. The accompanying report, "Towards Integrated Water Resources Management: International experience in development of river basin organisations" (UNEP 2014b), describes options for arranging catchment management approaches. This work should inform both the policy dialogue and the development of projects. The report shows a ladder of participation, demonstrating potential incremental steps towards achieving participation in water resources management.

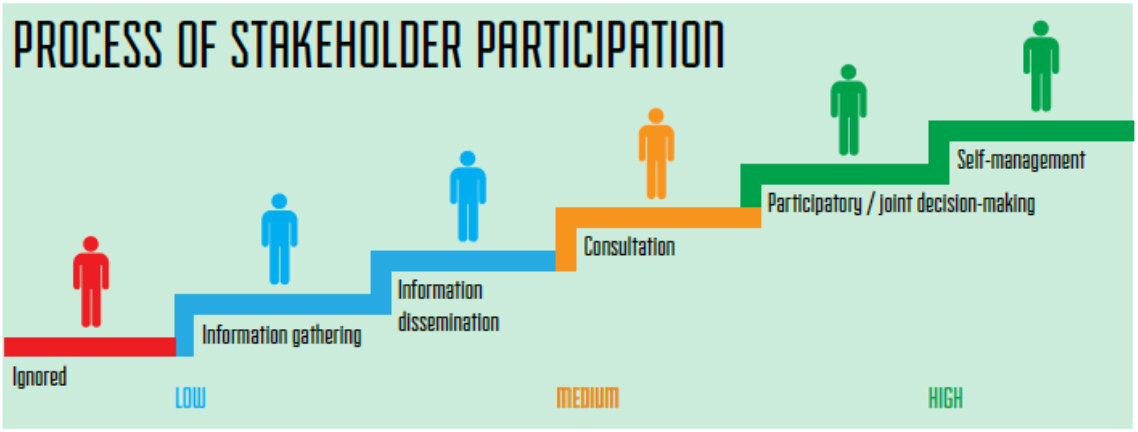

Figure 7.2 The ladder of stakeholder participation (Arnstein 1969)

8 Conclusion and recommendations

Figure 8.1 Wadi Azoum at Zalengei (Photo by Albert González Farran, UNAMID)

The analytical framework of this report was to review three different water management arrangements with respect to environmental sustainability, financial sustainability and the engagement of water users in management of the resources. Management of water schemes was identified as using a blend of approaches in which government acted as service provider (vertical social contract) or as enabler of co-management regimes (horizontal social contract).

The review of catchments identified impressive schemes in the Red Sea Hills and Nuba Mountains that operate with a high degree of community activity. These have a lower level of capital investment than the case study reviewed in South Africa; however, the principles are the same. In both cases, engagement of water users is enabling a collective approach to resource sustainability, bringing significant livelihood benefits.

Similarly, in the review of rural water supplies in drylands, the Hawata project in Gedarif and the Al Khewei project in Kordofan both clearly benefited from genuine local ownership. In UNEP's review, these projects stood out as having purchased spare parts before they were needed. The oversight by water users who finance the projects appears to be a critical factor in ensuring that this impressive management is maintained. These projects also show the highest levels of transparency and accountability. Al Khewei is of particular interest, given the departure of the NGO that provided external assistance – this project had lasting benefits long beyond the end of the aid spend. The achievements in Al Khewei set a challenge for aid agencies working in other parts of Sudan with respect to their own exit strategies. An important question arises around the respective aid spend on new boreholes and on supporting the development of management arrangements. Is aid money on new boreholes that are not well maintained well spent? Aid reporting based on beneficiary numbers appears to lack nuance in this area. What does it mean to provide water to a community? Results may be clearly reported if a new borehole has been drilled and fitted with a pump, but what are the criteria for the longevity of an effective supply, and how is this monitored?

An additional consideration in dryland water supply is the wider impact on the environment, where the provision of permanent water points draws a population of livestock too great for the surrounding natural resources. The result in these circumstances may be environmental degradation around the water point. It is encouraging to note experimentation with the use of bladders for livestock watering, as well as UNAMID's work on rehabilitating natural watering ponds. Greater awareness around maintaining the wider resource balance is clearly a priority. There are elements of good practice on which to draw. Within this context, a greater understanding of the respective

contributions of blue water and green water needs to be developed. Pastoralism has an important role as an efficient means of harnessing variable supplies of green water by allowing herds to move to locations where this water is captured in vegetation after rains. Research in tracking herd movements and remote sensing of vegetation has the potential to examine this interaction in more detail, and perhaps contribute to enhancing its efficiency.

The review of sustainability of urban demands identified the need for urgent action in Sudan's mid-sized cities. Whilst good practice exists, for example in the collective effort on capacity building and planning in Kassala, the need to develop strategic plans for Sudan's mid-sized cities is clear. Management for resource and financial sustainability needs to be prioritised. There is potential to achieve benefits from local engagement in the management of urban supplies, not least in the development of long-term strategies for achieving sustainability.

Growing agricultural demands and the economic potential for Sudan

FAO estimates that, as a result of population growth and changes in diet in Africa, overall food demand will increase by 221% by 2050, and demand for water intensive meat products will grow by 371% (Bruinsma 2009 in Hoff et al. 2013:359). Recent increases in the UN population projects suggest the real figures may be even higher. In addition, the demand for food from the Middle East, Europe and Asia is growing. The Middle East is demonstrating a shift in food security policy by looking to Africa for food production rather than growing it locally – as evidenced by the moratorium on groundwater for agriculture in Saudi Arabia. The potential for a foreign investment-driven surge in food production in Africa is therefore high. Governance and infrastructure are often cited as the constraints on such productivity. This lends particular urgency to the development of sustainable catchment management based approaches in Sudan, to enable the potential for such investment to be realised in an equitable way. A sustainable and well-governed resource base will provide the best returns both for investors and for local and national stakeholders.

The report has shown that examples of good practice exist in water resources management in Sudan. However, some worrying cases of unsustainable practices also prevail, particularly in urban areas. Both urban water management and aid-financed rural boreholes need a significant reorientation towards focussing on sustainability and effective local management. Resilience is a framework that lays greater emphasis on locally owned solutions, and so has potential to enable a shift towards greater sustainability of water supplies and water resources management. A coordinated approach to the promotion of IWRM could support government and communities across Sudan to develop a more resilient and sustainable water sector.

Recommendations:

1. **Strategic planning and project implementation for water, agriculture, livelihoods and urbanisation should be developed within or in conjunction with a framework of IWRM**, with a strong commitment to sustainability of water resources, cost recovery and an equitable basic supply for all groups.
2. **Increasing engagement of water users should be pursued as a means to promote sustainability and equitability of the water sector.** A step-wise approach is reasonable.
3. **The new GWWU hydrological database should be developed further.** The work should include drafting of guidelines for water developments in different hydrologically defined areas in Sudan. The success criterion for this initiative should be the degree to which it is useful to other actors planning and managing work on water.
4. **An emphasis on sustainability should be promoted in water-related courses in Sudanese universities.** Support should be provided for the IWRM Masters degree at the Sudan Academy of Sciences, and experience from running this course should inform courses in other universities.

Urban

5. **Sustainability assessments of urban supplies should be made for all state capitals in Sudan, and roadmaps to restoring both resource sustainability and cost recovery should be drafted** through expert input and consultation.
6. **Urban catchment management projects should be established.** These should integrate water supply, sanitation, solid waste management, flood control, water resources management, urban greening and livelihoods.

Catchment

7. **Catchment management projects should continue to be developed where appropriate.** Knowledge sharing amongst the initiatives in Ar Keweit, Wadi El Ku, Khor Abu Habil, El Gash should be enhanced. Security permitting, the effort could be extended to the Nuba Mountains and Wadi Nyala. Developing and implementing projects for upstream and downstream reaches of Wadi El Ku should be seen as a priority.

Drylands

8. **A widespread review of borehole and handpump sustainability challenges and practice should be undertaken** to identify priorities for government and donor expenditure.
9. **Work on WASH should continue to explore the potential for promoting resilience through community-led approaches** such as CLTS and CBNRM. Replication of projects like Al Khewei and Hawata should be prioritised. Emphasis should be placed on ensuring a supply chain of spare parts, and on effective and timely maintenance of handpumps and water yards.
10. **Water development protocols used in previous periods in Sudan should be reviewed in order to inform integrated approaches to dryland livelihoods and natural resource management.** These should address issues such as the spacing of hafirs used in livestock migration.

Coordination

11. **The IWRM policy consultation process should be concluded**, with working groups and government coordination strengthened, in collaboration with the Water Resources Council.
12. **Coordination for IWRM should be established within the UN,** with an approach reflecting the working groups on IWRM policy set up through the government IWRM policy consultations. The following working groups should be established:
    - Water supply – UNICEF (WASH), UNOPS, UN-Habitat (WASH coordination already exists).
    - Water and Agriculture – IFAD/FAO
    - Water, Science, Education - UNESCO
    - Water, Energy and Development - UNDP
    - Water Resources – UNEP

These working groups should convene periodically, both separately and together.

13. **The collaboration between South Africa and Sudan should be enhanced,** drawing on the priorities identified by delegates of the earlier tours. A new high-level study tour to South Africa could be undertaken with senior national decision makers.

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Annex 1: South Africa IWRM Study Tour Vision Statements

Darfur - South Africa IWRM Technical Study Tour Vision Statement and Recommendations

Cape Town 28 May 2010

Vision Statement

Water institutions, policy and finance

Effective collaboration between organisations based on clearly defined mandates and responsibilities.

Policies, strategies and law aligned for effective implementation of water supply and water resource management.

Water resources managed along catchment boundaries

Water user associations inform water sector planning through representative and well managed water boards and consultation processes. WUAs formed progressively at state, catchment and sub-catchment level.

A sustainable and equitable supply "Some, for all, forever" based on a stepped tariff policy that addresses:

- Affordable basic supply for low income users
- Cost recovery for water services

The need to limit demand, particularly in periods of drought

Sustainably funded programme of research providing cost effective and innovative solutions in partnership with water sector.

Master plans and drought management

Investment and implementation undertaken according to clear and strategic plans.

Mutual alignment of water supply, sanitation and resource management strategy with wider urban planning strategy.

Each organisation implements its activities according to a strategically prioritised and costed plan. This will bring organisational efficiency and improved collaboration with partners.

Transparent prioritisation of investment according to need and cost effectiveness.

Cost benefit analysis for triple bottom line (financial, economic, environment).

Reliable and complete databases readily available to planners and implementing agencies and researchers.

Status of water availability and implementation of drought response activities kept up to date and available for planning and management purposes.

Locations potentially vulnerable to drought implement mitigation measures to reduce impact and develop contingency plans for drought response

Communication and public relations

Water users active in demand management motivated on the basis of a sound understanding

Government agencies, parliamentarians, ministers and governors have good understanding of integrated water resource management principles and practice.

Children and their families grow in awareness and understanding and implementation of sustainable water management practices.

Engineering and technology

Sustainable, equitable, cost effective management of groundwater within IWRM approach

Sustainable, equitable, cost effective management of surface water within IWRM approach

Widespread uptake of rainwater harvesting and ongoing innovation and uptake of new methods

Cost effective leakage control implemented in all reticulated supply networks

Ecosanitation implemented including effective management of sludge as part of strategic approach for total sanitation.

Other recommendations

Effective collaboration between capacity building programme and internal training activities.

Support to institutions is well planned and is integrated into sector planning for humanitarian early recovery programming

Urban planning capacity increased to facilitate integrated development management in towns and cities.

Strategic use of study tours in all sectors to assist with visioning for post conflict programme objectives. Good management of tours maximises benefits for development of strategy in Sudan.

Recommendations

	Recommendation	Priority actions and responsibilities
Water institutions, policy and finance		
R1.1	Make clear assessment and presentation of respective **roles and responsibilities of water sector organisations**. Initiate process of reform and institutional strengthening where needed.	**1. Review and harmonize existing roles and responsibilities of water sector institutions. Consider appointing a consultant to undertake this task. (All organisations in collaboration).** **2. Strengthen collaboration and coordination raise sector awareness of respective mandates. (PWC/GWWD)**
R1.2	Assess the current status of both water supply and resource management **policies and strategies**. Initiate a process of reform and development where needed.	**1. Revise and update the strategies, policies and law for water resources (MIWR, GWWD)** **2. Complete water supply policy and strategy processes with clear distinction of roles between water supply and water resource management. (MIWR, PWC, GWWD).**
R1.3	Manage water resources according to **hydrological boundaries**.	**1. Complete mapping of hydrological boundaries taking consideration of groundwater and surface water flow.** **2. Make data collection for water resources mandatory** **3. Re-establish catchment management organisations (GWWD)** **4. Modify internal management structure accordingly (GWWD).** **5. Promote conjunctive surface and groundwater management – IWRM (GWWD).**
R1.4	Improve **role of water users** in water resource management	**1. Revitalisation of WUA and promotion of democratic selection of members. (SWC and GWWD)** **2. Reactivate existing water user associations** ***3. Stakeholder analysis and formation of water management fora as per UNEP programme.***
R1.5	Improve **tariff policy and cost recovery** for urban water supplies.	**1. Review the existing tariff system. (PWC/SWC and state legislative councils)** **2. Develop appropriate tariff system/policy (PWC/SWC and state legislative councils).** **3. Orientation on water tariff policy improvement for political decision makers and key community leaders (PWC/SWC)**
R1.6	Improve links between **research** and water policy and programming	**1. Allocate budget for research at national and state level (SWC)** **2. Build capacity of local level institutions for effective participation in research programmes (State level research institutions).** **3. Asses potential to establish a national research commission (PWC/GWWD)**
Master plans and drought management		
R2.1	Develop **water resource master plans** for cities and rural areas	**1. Conduct town water supply studies – identify supply gaps (SWC GWWD)** **2. Prioritise investment at areas vulnerable to drought (GWWD, SWC)** **3. Develop investment plans to resolve gaps between supply and demand (GWWD, SWC)**
R2.2	Link water supply and sanitation strategies with urban	**1. Develop a clear strategy for provision of water supply for urban and peri-urban areas.**

	zoning and **urban development plans**.	**(SWC/WES/SMUP)** **2. Coordinate relevant stakeholders (SWC)** **3. Assess feasibility of water bourn and eco-santiation urban sanitation, and develop projects accordingly.(SMUP, SMOH, PWC).**
R2.3	Develop **institutional business plans** and investment plans.	**1. Develop annual investment plan based on the master plan (SWC, PWC, GWWD).**
R2.4	**Prioritise interventions** an analysis of benefits and costs including social and environmental considerations.	**1. Implement needs assessments that include consideration of environment ,social and economic factors (SWC)** **2. Project development must include an Environmental Impact Assessment. (SWC)**
R2.5	Review and strengthen **data management** in water supply and water resource management.	**1. Assess gaps / overlaps of water supply and resource databases, improve complementarity and resolve inconsistencies.** **2. Undertake capacity building programme for GWWD data management.** **3. Make databases available for all users.**
R2.6	Build and maintain effective **drought management** capacity including updated drought status and analysis	**1. Develop and maintain water resource status indicators.** **2. Develop and implement communication strategies for drought.**
R2.7	Develop regional and local **drought preparedness plans**	**1. Develop regional drought contingency plans** **2. Develop integrated lower level drought early warning practices (GWWD SMOAgric).**
Communication and public relations		
R3.1	Prepare and implement **communication strategies** to inform water users of water supply and resource strategies.	**1. Raise public awareness through media, workshops and report dissemination (SWC)**
R3.2	Develop and implement strategy to **raise awareness of Integrated Water Resources Management** within government and civil society.	**1. Raise government and civil society awareness through workshops and report dissemination & study tours.**
R3.3	Introduce water management issues to **school curriculum**	**1. Introduce water management issues to school WASH activities (WES/PWC)** **2. Advocacy and dialogue with Ministry of Education. (PWC, GWWD).**
Engineering and technology		
R4.1	**Improve groundwater management**	**1. Streamline data collection and monitoring (GWWD)** **2. Regional monitoring and capacity building (GWWD).** **3. Comprehensive groundwater studies and research (GWWD).**
R4.2	**Improve surface water management**	**1. Regional assessment and ongoing monitoring for surface water management** **2. Develop capacity building programme including institutional strengthening and provision of monitoring equipment (SWC, GWWD)** **3. Undertake research in catchment management (GWWD)**
R4.3	Increase and improve coverage of **rainwater**	**1. Assess and adopt a range of innovative water harvesting and supply techniques (SWC and**

	harvesting and other innovative water supply methods	**GWWD) (WES, SWC, University of Nyala)**
R4.4	Develop and implement **leakage management** plans for water supply networks	**1. Conduct assessment for network leakage (SWC)** **2. Rehabilitation/renewal of leaky networks (SWC)** **3. Build SWC staff capacity for leakage control. (SWC & PWC)** **4. Introduce modern technology for leakage control (SWC)** ***TDRA have a project planned for renewal of networks in Darfur state capitals awaiting full implementation.***
R4.5	Trial and if appropriate scale up use of **eco-sanitation**	**1. Pilot Eco-san technology in selected communities (SWC, WES)** **2. *Evaluate and scale up subject to evaluation.* (SWC, WES)**
Other recommendations		
R5.1	Implement **targeted capacity building** programming to water institutions to enable effective implementation of recommendations above and facilitate creating of learning environments.	**1. Develop complementary inter-sectoral capacity building strategy and plan (PWC & GWWD)** **2. Establish links with academic institutions. (PWC & GWWD)** **3. Implement effective staff training programmes and improve staff motivation (SWC, PWC, GWWD).**
R5.2	Promote **integration of capacity building** and programme delivery **in Humanitarian[32] and Early Recovery Programmes**.	**1. Ensure capacity building to be integrated with action in the humanitarian and early recovery programmes (SWC GWWD PWC WES & HAC).**
R5.3	Support **urban planning processes** in Darfur's rapidly expanding towns and cities.	**1. Develop holistic master plan for urban centres (State ministry of Urban Planning).** **2. Follow up studies and relate these to water and sanitation (SWC/WES).** **3. Improve the use of environmental practices in construction.**
R5.4	**Use** study tours **for shared learning, vision building and strategy development for Early Recovery Programmes**	**1. Organise tours for technical people and decision makers** **2. Take forward recommendations from this study tour developing and refining the vision and implementing recommendations. (All)** ***3. Disseminate benefits of this tour within ER network.***

Note on Process

This consolidated note represents work undertaken by three groups of participants on the first UNEP Study tour of South Africa from 16 to 28 May 2010 reviewing IWRM policy and practice. The purpose of the tour was to provide decision makers within Khartoum and Darfur with the opportunity to develop a vision and programme of practical actions for how IWRM can be implemented in Darfur by seeing how IWRM influences planning and management in South Africa. The tour was hosted by the Water Research Commission of South Africa.

The recommendations were made by groups that met intermittently during the tour. UNEP's international staff acted as a secretariat for the formulation of the recommendations rather than as members of the working groups. A list of participants on the tour is provided below. Recommendations in italics have been added to the record after the tour and have been included where obvious gaps in activity have been identified, or new information has come to light. The

[32] See Good Humanitarian Donorship principle number 8.

group work concluded with a plenary workshop in Cape Town on 28 May. More details are available on the methodology of the consultation process by which these consolidated recommendations were made on request (including conclusions of each group which form the basis of this document).

The recommendations, including the allocations of responsibility represent discussions of participants rather than formal policy of any given organisation. They are provided in order to inform development of programmes, strategy, policies and institutions for the water sector.

UNEP's Integrated Water Resource Programme includes collaboration with Federal and State Authorities, UNICEF, Groundwater and Wadis Directorate and the Water and Environmental Sanitation Project (WES) of the Public Water Corporation on water management, and with UNOPS and SWC on dam construction. The programme is funded by the government of the United Kingdom (DFID).

Darfur South Africa IWRM technical study tour participants – 16th to 28th May 2010

	Name	Role	Nationality		Name	Role	Nationality
1	Mr. Mustafa Abdelraheim Yousif	DG,Groundwater and Wadis - Federal	Sudanese	10	Mr. Nasrelddein Mohamoud Mohamed	WES coordinator, North Darfur	Sudanese
2	Mr. Fadul Mahamoud Nasur	DG, State Water Corporation, SD	Sudanese	11	Mr.Mohammed Gydoum Mohamad Gadim	WES coordinator, West Darfur	Sudanese
3	Mr. Mohamed Mahamedain Adam Sabi	DG, State Water Corporation, ND	Sudanese	12	Mr. Khalid Musa	UNICEF, West Darfur	Sudanese
4	Mr. Mahamoud Abdella Bashir Gammaa	DG, State Water corporation, WD	Sudanese	13	Mr. Suliman Mohamoud Arabi	UNICEF, South Darfur	Sudanese
5	Mr. Hamdan Mastour Ibrahim	Groundwater and Wadis Directorate, SD	Sudanese	14	Dr. Hamid Omer Ali	UNEP Consultant– UNEP/UNICEF IWRM programme	Sudanese
6	Mr. Omer Abdulrahman	Groundwater and Wadis, Directorate, ND	Sudanese	15	Mr. Ahmed Abdalla Hussein Maniese	UNICEF– UNEP/UNICEF IWRM programme	Sudanese
7	Mr. Tayalla Ahmed Elmedani	WES Darfur progamme Coordinator	Sudanese	16	Mr. Tom Maisiba	UNEP– UNEP/UNICEF IWRM programme	Kenyan
8	Ms. Shaza Omer El Khawad	WES Darfur programme monitor	Sudanese	17	Mr. Brendan Bromwich	UNEP Darfur Programme Coordinator	British
9	Mr. Mohammed Mustafa Fadul	WES coordinator, South Darfur	Sudanese				

WES is the Water and Environmental Sanitation Project of the Public Water Corporation.

South Africa Integrated Water Resource Management (IWRM) Decision-Makers' Study Tour
Recommendations made at wrap up meeting Cape Town 6 November 2010

1. Endorse the IWRM and catchment management approach, and take this forward for endorsement in state capitals.

2. Establish collaboration between 3 states, TDRA, Council for Development for Nomads, Federal ministries and other partners – (wadis & water users cross state boundaries). The forum should include the following organisations (this list may be developed further on consultation):

- Ministry of Water and Environment –South Darfur
- Ministry of Urban Planning – West Darfur
- Ministry of Urban Planning – North Darfur
- Ministry of Agriculture and Irrigation – North Darfur
- Ministry of Agriculture and Forestry – West Darfur
- Ministry of Agriculture and Forestry – South Darfur
- Ministry of Environment Forestry and Physical Development
- Groundwater and Wadis Department
- Darfur Reconstruction and Development Fund (TDRA)
- Darfur Land Commission (TDRA)
- Council for the Development for Nomads
- Public Water Corporation
- Ministry for Electricity and Dams
- Ministry for Irrigation and Water Resources
- Darfur strategy group
- Ministry of Finance
- Ministry of Agriculture
- Forestry National Corporation
- University of Nyala
- University of El Fasher
- University of Zalengei
- UNEP (secretariat, and advocacy role)
- UNAMID
- UNICEF/WES

- FAO
- WFP

3. Establish working group to develop and implement action plan on IWRM for Darfur addressing the following seven themes:

a. Hydrological management
b. Stakeholder participation
c. Urban water Management
d. Integrated development planning
e. Legal & Institutional
f. Financial
g. Projects

The working group shall comprise the following organisations (any additional organisations to be added following consultation).

- Ministry of Water and Environment –South Darfur
- Ministry of Urban Planning – West Darfur
- Ministry of Urban Planning – North Darfur
- Groundwater and Wadis Department
- Darfur Reconstruction and Development Fund (TDRA)
- Darfur Land Commission (TDRA)
- Council for the Development for Nomads
- Public Water Corporation
- UNEP (secretariat)

4. Establish supportive collaboration with Ministry of Irrigation Water Resources (Republic of Sudan) and the Department of Water Affairs (Republic of South Africa). The following four technical themes are to be prioritised:

a. Catchment management
b. Development of water resource law, policy and strategy & institutional framework
c. Research and capacity building
d. Water harvesting techniques

5. Review & strengthen national policy, strategy & institutions for IWRM for Non-Nilotic waters.
a. Build capacity of Groundwater and Wadis Department and state level institutions
b. Review & reform institutional framework for Non-Nilotic & groundwater
c. Review national strategy & policy for Non-Nilotic water resource management
d. Build capacity of research institutions
6. Request UNEP to undertake a facilitation, advocacy, research role to promote IWRM.

Note on Process

These recommendations were made by the decision makers study tour to South Africa –1st to 7th November 2010. The tour was undertaken under UNEP's IWRM programme in Sudan. These recommendations were developed by the delegates including adoption by the group during a half day workshop on 7th November in Cape Town. The purpose of the tour was to provide water supply & resource managers and decision makers within Darfur the opportunity to develop a vision and programme of practical actions for how IWRM can be implemented in Darfur by seeing how IWRM influences planning and management in South Africa. A list of the study tour delegates is provided below. UNEP's international staff acted as a secretariat for the formulation of the recommendations rather than as members of the working groups. A list of participants on the tour is provided below. These recommendations build on earlier recommendations made during the technical study tour 16th to 28th May 2010 and on the recommendations made in the El Fasher climate change retreat 23-24 March 2010. The recommendations, including the allocations of responsibility represent discussions of participants rather than formal policy of any given organisation. They are provided in order to inform development of programmes, strategy, policies and institutions for the water sector.

UNEP's Integrated Water Resource Programme is implemented collaboration with federal and state authorities, UNICEF, Groundwater and Wadis Directorate and the Water and Environmental Sanitation Project (WES) of the Public Water Corporation on water management, and with UNOPS and SWC on dam construction. The programme is funded by the Government of the United Kingdom (DFID). This study tour was funded by the Government of Italy.

South Africa IWRM Decision-Makers' Study Tour Participants – 1 to 7 November 2010

	Name	Title	Institution	Nationality		Name	Title	Institution	Nationality
1	Adam Abbakar Bashir Mohammed	Undersecretary	Ministry of Irrigation and Water Resource	Sudan	9	Mr. Mohamed Eltigani Eltayeb Salih	Chairperson	Darfur Reconstruction & Development Fund	Sudan
2	Mr. Mustafa Mohamed Ishag	Speaker	Legislation Council of West Darfur	Sudan	10	Dr. ELFadil Ali Adam Khalil	Advisor	Ministry of Environment , Forest and Physical Planning	Sudan
3	Dr. Ibrahim Adam Ahmed El-Dukheri	Minister	Ministry of Agriculture South Darfur State	Sudan	11	Mohamed El Agib Ismail El Safi	Chairperson	Legislation Committee, Legislation Council South Darfur	Sudan
4	Mr. Elfatih Abdelaziz Abdelnabi Adam	Minister	Ministry Urban Planning and Public Utilities	Sudan	12	Dr Mohamed Suliman Adam Ali	Project coordinator	Transitional Darfur Regional Authority	Sudan
5	Hassan Mohamed Kaskous Bilal	Minister	Minister of Water Resources & Environment, South Darfur.	Sudan	13	Ms Zeinab Ahmed El obeid Azrag	Coordinator	Training Department Women Bureau NCP	Sudan
6	Ms. Hawa Suliman Husain Easa	Minister	Minister of Agriculture, North Darfur	Sudan	14	Mr. Robin Bovey	Programme Manager	UNEP	Canadian
7	Ibrahim Ahmed Adam	Deputy Director General	Public Water Corporation	Sudan	15	Mr Brendan Bromwich	Programme Coordinator	UNEP	British
8	Eng. Adam Abdelrhman Ahmed Abdalla	Commissioner	Darfur Land Commission, Khartoum	Sudan					

Annex 2: IWRM Joint Concept Note

Integrated Water Resource Management (IWRM)

Policy formulation, institutional strengthening and capacity building and implementation

CONCEPT NOTE 31 May 2012

Rationale

Sudan faces numerous concurrent challenges in the management of natural resources, particularly water. These challenges include the impact of climate change with increased frequency and severity of droughts and floods, a rising population, changing livelihoods and expectations, and rapid urbanisation. These challenges create tensions between water users particularly in rural areas. Therefore an overarching objective for water managers and government decision makers emerges, which is to reduce and manage the risks of conflict.

Conflict over resources can be usefully analysed with a focus on livelihoods. This analysis addresses fundamental issues in the links between natural resources and human activity, including conflict. What becomes clear is that improving systems of governance is essential to reducing conflict over natural resources. One of the key challenges is the development of participatory processes in a context of a diverse range of water users. An area of particular importance is supporting the bridge between government and communities, who are often represented at least in part with traditional leadership. This context of legal plurality between traditional and government systems creates its own challenges in enabling dialogue between water users and managers. The livelihoods based approach also brings the spotlight onto poverty alleviation which is a pressing concern in Sudan and an important objective for improved management of water resources.

In addition to social and economic considerations, governance of water resources requires a sound technical footing. Therefore any attempt to improve water resource management must tackle issues of data collection, data management, analysis of surface and groundwater flows and related technical matters. These responsibilities come under the mandate of the Groundwater and Wadis Department of the Ministry of Irrigation and Water Resources. Whilst Groundwater and Wadis have a lead in the technical arena, the effective management of water resources requires collaboration of numerous different organisations at federal, state and community level.

Integrated Water Resource Management

In 2005 Sudan made a commitment to implement Integrated Water Resource Management in order to promote sustainable and equitable management of water resources. IWRM is distinctive in the following ways:

- Water resources are managed in their entirety addressing the needs of all water users and the environment. This is usually done watershed by watershed.
- Water users are represented in a participatory approach
- A balance of economic considerations, basic needs, and environment is achieved.
- The role of women in management of water resources is emphasised

This approach is well suited to tackling the water resource challenges described above.

IWRM Programme

In 2007, at the request of the government of Sudan UNEP undertook a comprehensive review of the environment in Sudan. In line with the government's own undertakings, UNEP recommended IWRM to be supported in Sudan with a particular focus on a number of degraded wadi basins. Since that time UNEP has mobilised to Sudan and has implemented a successful programme to integrate water resource considerations in the UN humanitarian and early recovery programme in Darfur and to raise awareness of IWRM. This work included two successful study tours to South Africa to review how South Africa has implemented IWRM in the post-apartheid era to promote inclusivity and sustainability of water resource management. These tours have resulted in the development of a shared vision on IWRM with stakeholders from Khartoum and Darfur. In addition, as a result of links made on these tours, MIWR is now in contact with the South African Department for Water Affairs and the Water Research Commission on issues relating to capacity building.

Proposed Collaboration

UNEP seeks to work in partnership with MIWR to build on the current initiatives in IWRM to a larger scale programme for Sudan. The objectives of the work would be three fold:

1. To support MIWR in the formulation of policy and strategy for IWRM with a focus on non-Nile water resources.

2. To implement participatory catchment management in a number of degraded Wadi basins in Sudan on IWRM principles

3. To support institutional strengthening of IWRM stakeholders with a particular focus on Groundwater and Wadis department.

The support on policy and strategy formulation would take due consideration of the need to operate at both federal level and state level in Sudan and for the need for harmonised policy and strategy at both levels. Therefore a number of states would be included in this process of policy and strategy formulation. The work would also require a concerted approach with other ministries, including UNEP's contact Ministry – Ministry of Environment, Forests and Physical Development, Ministry of Electricity and Dams, Ministry of Agriculture. In addition the Hydraulics Research Station and the Higher Council for Environment and Natural Resources have potential to be significant partners.

The project implementation would be undertaken in a manner that both informs and is informed by the development of policy. This will ensure that the policy and institutional work is well grounded in the realities of Sudan's natural environment and the livelihoods that depend on it. The work will be undertaken with both national and international partners. UNEP would work with MIWR and other stakeholders to identify appropriate project locations.

Institutional strengthening will comprise both the focus on the role of GWWD and the wider range of activities on enabling participating organisations on water resource management. This work will include enabling an international dimension to capacity building by supporting the proposed bilateral cooperation identified during the study tours to South Africa. The work would include assisting GWWD fulfil their mandate including continuing to support their engagement with international projects such as those under WASH sector in Darfur. There would be potential to develop other capacity building programmes, either as part of this project or as outputs from this project to be managed by others.

Project modalities

a. The work would be undertaken in partnership with MIWR, MEFPD, UNEP and UNDP under the overall leadership of MIWR. UNDP have joined this collaboration as of 31 May 2011 in order that their proposed follow up to the NAPA that includes catchment management initiatives contribute to the objectives on IWRM described in this concept note. The UNDP work focusses on the second priority on implementation of degraded basins and strengthens the links with climate change.

b. This document builds on the earlier concept note of 23 February 2011. MIWR would initiate and coordinate cooperation with other ministries and Sudan as required. UNEP would initiate and coordinate collaboration with other UN agencies and INGOs. MIWR would lead the process of policy and strategy formulation for IWRM on non-Nile waters. MIWR would lead the international collaboration with the Republic of South Africa. Other international collaboration would be developed on a case by case basis.

c. The work would be funded with contributions from both international donors and the Government of Sudan.

d. The work will be covered by agreement between MIWR, MEFPD and UNEP and a joint management structure will be established

e. The financial arrangements would include the establishment of a dedicated project account for Groundwater and Wadi's Department so that they may undertaken work with joint national and international funding. Additional accounts for state level offices and with other organisations may be considered on a case by case basis.

Way forward

1. Consultation and adoption of a joint concept note
2. MIWR request UNEP to assist with this work
3. Establishment of joint management procedures
    a. Agreement established (Item c. above)
    b. Working group as recommended by IWRM Decision-Makers Study Tour 6 November (Item 3) with addition of MIWR to the group
4. Establishment of joint project accounts
5. Development of project note, programme and proposals for funding
6. Fundraising
7. Project implementation
8. Monitoring and evaluation
9. Project closure / continuation

Reference Documents and Consultation Records

- *UNEP's Post Conflict Environmental Assessment – Chapter 10 Freshwater resources http://postconflict.unep.ch/publications/sudan/10_freshwater.pdf*
- *Recommendations from two South Africa study tours in 2010 with Sudan Government delegates coordinated by UNEP (See attached).*
- *Adapting to climate in Darfur, El Fasher, March 2010 http://climatechange.sudanct.net/*
- *UNEP report "The case for drought preparedness" http://postconflict.unep.ch/publications/darfur_drought.pdf*
- *United Nations Development Assistance Framework for Sudan (Output 4.4.2) http://www.sd.undp.org/frameworks/Sudan%202009-2012%20UNDAF%20august.pdf*
- *Beyond Emergency Relief - Longer term trends and priorities for UN agencies in Darfur www.unsudanig.org/docs/Darfur_LT_100905_med.pdf*

Annex 3: Drinking Water and Sanitation Unit Programme for Water Quality Monitoring in Sudan

AMCOW in its 5th water week in May 2014 in Dakar, Senegal addressed the issue of waste water .management and water quality in Africa. The meeting stressed the significance of access to significant quantity and quality of water as a human right and emphasised the shared responsibility for water quality where all stakeholders are involved including industry, farmers, and political decision makers.

DWSU is planning for implementation of water quality monitoring based on AMCOW approach and considering that it is one of the tools that will enhance IWRM process and will ensure effective use water. Planning process will focus on monitoring of water quality from sources to users; through water safety planning that will ensure water supply is safe for drinking for the end users at homes. The process will involve all water quality and IWRM related partners; communities, FMOH, SMOH, UNICEF, WHO, SWC, WES, GWWD, UNEP, NNGOs, INGOs and others.

Currently all WASH partners conducting water quality analysis/assessment for the new sources and conducting monitoring during rainy seasons to avoid outbreak of water related diseases, however, the main challenges facing water quality monitoring is lacking of integrated approach for water quality monitoring; disintegration and scattered information over different partners along with limited capacities and inactive laws and regulations supporting preventive measures to ensure good water quality. The process of water safety plans will ensure monitoring of water resources in the catchment or the groundwater basin, in addition to the safety at the sources (hafirs, dams or boreholes) passing through water transportation, storage and use at household level. To do that DWSU along with partners will build on strengths within the water sector that include; laboratories at state and national levels; database that include water quality aspect; water surveillance experience of State Ministries of Health (SMOH) & the World Health Organisation (WHO) especially in emergency situations along with staff experience in monitoring of quality of water resources and supply and integrating water quality aspects to the overall role of WASH in IWRM process to enhance holistic management of water resources.

Source: Drinking Water and Sanitation Unit. 3 July 2014